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March 3, 1932

Economics of Oil-Processed Roads
Lake Union Bridge in Seattle
Harbor Improvements at Southampton, England
Projected New Water Supply for Paris
Sinking Steel-Lined Tunnel Shafts
Erecting Bascule Span of Arlington Memorial Bridge
Relation of Road Design to Traffic Accidents
Labor's Share in Highway Construction
Lightweight Railway Car of Radically New Design

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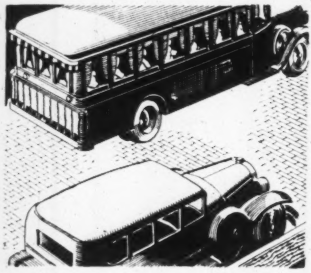

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Engineering News-Record

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F. E. Schmitt, Editor

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Leading Articles

Economics of Oil-Processed Roads . . 310
Lake Union Bridge in Seattle 313
Southampton Harbor Work 314
New Water Supply for Paris 316
Sinking Steel-Lined Tunnel Shafts . . 317
Bascule Span of Arlington Bridge . . 318
Municipal Financial Difficulties 321
Road Design and Traffic Accidents 322
New Lightweight Railway Car 326
Labor's Share in Road Construction . 328

A Beginning

MUNICIPAL financing of the past week gives some faint hope that relief of the money stringency involving local governments and their public-works projects has begun. Buffalo sold its bonds and notes at a rate that is not unreasonably high under the conditions of the times, though only a week earlier it had found no market at all. Several happenings of this kind suggest that the functioning of the Reconstruction Finance Corporation and the prospect of early passage of the Glass-Steagall bill (finally approved on Feb. 27) partly thawed the frozen rills of credit. But this conclusion rests on a slender base. One swallow does not make a summer, and it will take more convincing evidence of improved municipal credit to give assurance that the "bankers' strike" is ended and normal public construction operations can be resumed.

Now to Make Jobs

THE Glass-Steagall bill has been enacted, and the most serious obstacles to liquidity of money and credit are now removed. The time is at hand to make jobs. Credit can be converted into business activity by enterprise, courage and business aggressiveness alone. If the community is to move forward, it must be through the individual advance of each man for himself. And this in turn depends on faith in the future and clear recognition of the fact that the country has been sold down to a beggarly scale of values, utterly belying the strength of its possessions and its purpose. Worst of all the depressing elements at the moment is the partial abandonment of public-works construction and the progressive trend of legislative action toward further shutdown. It is time to reverse this policy, and to make jobs instead of destroying them.

Effective Public Credit

POTENTIALLY the way has been cleared for mobilizing credit sufficient for all purposes that the country may require. Actual creation and distribution of the credit will doubtless take some time, and its effects may not be fully apparent until early summer in the restored standing of municipal securities. Before that point is reached it is quite possible that public construction will shrink almost to the vanishing point, and that thereby earning power and public confidence will be severely shaken. To provide against this contingency the organization of a municipal securities corporation under federal aspices is being advocated similar to the Reconstruction Finance Corp. Its function would be to purchase the bonds of cities and other local governments and thereby supply funds for maintaining and where necessary extending public works. The importance of the proposal is clear, in view of the predominating part played by local construction in the country's public-works total; federal construction normally is but a tenth of the total, and even in these depression years has not reached a fourth. If the proposal succeeds in gaining the attention of Congress it will claim the unanimous support of engineers as an effective means of averting a menacing contraction of industrial activity.

Not Clarified

BY DECLINING to pass on the merits of the Mississippi floodway land-damage cases and turning its decision on technicalities of procedure, the U. S. Supreme Court last week created further confusion in the already badly mixed affairs of the flood-protection undertaking. Congress now will have to unsnarl the tangle. Without such action the government's agents are free to go ahead so far as procedure is concerned, but lack authorization to incur the financial obligations that are likely to follow. It is clear that Congress did not intend and that equity would not permit the appropriation of private property as the bed of a flood channel, unless compensation be paid; but the Army engineers tried to do this very thing, and the Delphian utterance of the Supreme Court appears to encourage them in this attempt, even though it may bring ruin upon many of the local people. It is the obvious duty of Congress to settle the question by clarifying its language in respect to the Mississippi flood-control work. This is the more desirable because the hearings in the lower court revealed conditions that promise to make future damage suits costly to the taxpayers. The way out is to prescribe by suitable legislation a sound and equitable procedure for land takings, based on fair appraisal of the economics of the flood-protection program.

Patriotism Rampant

THE natal day of the Father of his Country saw the dedicating of at least one more George Washington Memorial Bridge. With about the same basis of logic as has attended previous selections of this name, Seattle saw fit to christen its new high-level bridge across the Lake Union ship channel from motives artificial rather than natural. If this be popular opinion, it would seem that our first President has been unanimously chosen patron saint of bridge structures. The situation might even reach the point where the success of a bridge engineer would be counted in terms of the number of George Washington bridges he had built. It is a distinct relief that no gesture was made to fasten this title on the San Francisco Bay project at the ceremonies held about the same day on Yerba Buena Island in the bay, when the governor officially initiated the undertaking. At this early date it is timely to urge that the notable Bay bridge be allowed to retain its present logical and descriptive title of San Francisco-Oakland Bridge—a distinctive name, significant of the physical bond it will create between the two communities.

Prices and Standards

WITH falling prices and decreasing business volume ruthless competition has come to exist in many important industries. Price tends to become the sole determinant of purchase and sale under these conditions, and the pressure to lower quality is hard to resist. To the credit of industrial principle be it said that this pressure has been resisted in remarkable degree. But can the record be maintained as this pressure is further intensified with declining business and shrinking resources? The answer rests with manufacturer, dealer and purchaser alike. Particular responsibility, however, devolves on the engineer, not only in specifying but also in verifying the actual delivery of full specified quality. So long as he stands unwaveringly for complete performance he strengthens the hand of the capable and conscientious manufacturer. Standards must be maintained if we are to come out of present troubles in sound condition, and the engineer plays a large part in assuring their maintenance. Where because of his own inadequate compensation he omits or slights inspection, he fails in his manifest duty to client and community.

More Light Wanted

DISCUSSION of Treasury Department design of public buildings against design by private architects brought out interesting figures in Congressional committee hearings some days ago. Architects' organizations urged that buildings be designed by private architects, but the Supervising Architect's office countered with the claim that its costs are little more than half those of private design—2.7 against 4.8 per cent. A good deal of uncertainty surrounds the figures, but even after heavy discount the claim is not plausible. We have much respect for governmental efficiency, though not so much respect for the remarkable collection of post offices which the Supervising Architect's office has created during its history; yet we doubt whether the claimed difference could be proved in a fair comparison. If it could, the methods by which such remarkable economy in manpower and effort is attained should be made known to the world. Is repetitive and standardized designing the secret? And if so, is it appropriate to the planning of great buildings for specialized service in individual locations? Are its effects similar to the results of planing-mill housebuilding? Has routinized low-cost design always produced the best and most economical building? Rumors that we have heard of hitching posts and like antiquities in some recent government building plans are probably apocryphal, but they do suggest certain essential differences between creative design and mass-office design in the planning of buildings. The truth ought to be made clearer than the hearings left it.

Politics Obstructs Relief

INDICATIONS are appearing that emergency loan legislation for highway construction has become a contentious political issue. Announcement that the House passed the Almon bill providing for an emergency loan to the states of $132,500,000 to enable them to meet federal-aid appropriations was followed promptly by an announcement that if the bill is not killed in the Senate it is reasonably certain to be vetoed. Secretary of Agriculture Arthur M. Hyde, apparently in the role of administration spokesman, displays all the characteristics of the cart-tail campaign speaker in calling the relief act pork-barrel legislation and in scoffing at the small amount of employment which the appropriation would afford. So absurd a statement as that only 35,000 direct employees and less than half as many indirect employees would benefit from the expenditure of $132,500,000 could be seriously presented only by one totally blind to the facts. If this loan will not relieve unemployment, what then of the exactly similar loan of $80,000,000 which a year ago the administration sponsored as a masterstroke in its unemployment-relief programs? Let us hope that Congress can see its way to more statesmanlike thinking than that offered in the Hyde statement.

Road-Hazard Accounting

A PERTINENT variation of the prevailing explanation of highway traffic accidents is offered by Prof. Harry Tucker, of North Carolina State College, in an article in this issue. It is that the road presents hazards quite as provocative of accidents as are the habits of road users. With a million accidents and thirty-five thousand fatalities a year (these are the 1931 figures of the Travelers Insurance Co.), this thought deserves the close attention of our accident statisticians.

Nine out of ten motor-vehicle accidents, states a recent statistical publication, are attributable to human error. This is a fair representation of official statistical opinion generally. In the sense that all accidents are caused by man's neglect in some form such assertions are doubtless true enough. But they are not made with this meaning. What the writers mean is that the travelers on the road, solely through their own fault, are responsible for nine-tenths of the motor-vehicle accidents. With such an interpretation of accident figures. We must disagree.

It has unfortunately become so general a habit of accident statisticians to damn the driver that few ever think of properly characterizing the engineering of the road on which he must drive. On the whole, motor-vehicle drivers are remarkably expert. Most of them know how to drive safely. They do exceedingly well in avoiding the possibilities for accident that, by and large, the highways provide. A million accidents and thirty-five thousand fatalities each year show that many do not drive safely. At least part of the reason lies in the fact that the roads offer hazards beyond the ability of drivers to avoid.

The highway engineer is fully aware of the faults of the road. He knows how to build roads that offer no hazards. The reason he does not build them is that the public demands that its road money shall be used to purchase mileage instead of safety. In general the highway engineer has shown remarkable skill in getting the maximum of road safety practicable within the limits of expenditure for safety that public opinion would approve. But roads as they are being built are not safe to the degree that engineering can make them safe. And a good share of responsibility for this condition rests on the reiterated statement that accidents are mainly due to drivers' carelessness.

The public needs better teaching by accident prevention agencies. Conviction needs to be established that the road as well as the habits of road users presents hazards provocative of accident. The fool driver is with us and will continue to be with us. So is the foolish hazard in the highway with us. But this hazard need not continue; and it will not continue if traffic-accident bureaus make as frequent and as careful an accounting of road hazards as they make of the mishaps and fatalities of those who travel the roads.

Changes on the Mississippi

CHANGED conditions confront the engineers and builders of flood-control works on the Mississippi River. Following two years of practically continuous within-bank flow the river has reached this month the bankfull and overbank stages which characterize its normal spring regimen. In fact the high-water season is somewhat advanced. Bankfull stages are not usually reached so early in the season.

With a saturated ground and a full river retarding the runoff from the tributaries, all is ready for a possible serious flood situation when the normal spring rise of a month hence swells these tributaries. Obviously, what may happen is at present only speculation. The normal equinoctial rains may not fall, but if they do the lower Mississippi Valley is destined again to experience flood conditions—not necessarily uncontrollable high water, but stages which call again for the preparedness and prearranged plans of many past springs for combating overflow.

The return of the valley streams to normal spring flood conditions is reflected in prompt action by the levee organizations of the valley to preserve their flood-protection works. Gen. Lytle Brown, Chief of Engineers of the Army, has sounded the call for preparation, and his division and district engineers on the river are assembling the working agencies. At meetings of the federal, state and local levee officials in the last few weeks agreements have been reached for mobilizing resources and consolidating the lines of battle. These agencies are meeting changed conditions with changed thinking. The example should prompt changed thinking by the contractors who will undertake the new work of the coming season.

Two years of virtually drought conditions have reduced costs and increased performance to abnormal figures on both levee construction and within-bank dike and revetment work. Lower wages, improved equipment and better construction management have emphasized the gains to the contractor. They will continue effective, but in the last analysis it is water conditions that control costs and outputs on the river work. Water in the form of soil saturation, seepage, rain and overflow has not been a factor for two years; with present river conditions it becomes a dominant factor which calls for a new appraisal of working conditions, costs and performance: Forgetfulness of these facts may spell disaster to the river contractors this year.

But, on the other side, there need not remain the old fear of water. Three years of the new levee work have witnessed notable advances in drainage planning and practices. Firms under engineering direction have stepped into the field and by scientific drainage have overcome ground and seepage water troubles that under old practices would have prevented profitable earth moving. The contractors of 1932 can enlist an improved technique of handling water in levee construction.

More Than a Shovel Buried

"SPADE in hand, Alderman J. M. Savignac, of the executive committee, faced a gathering of over 100 workers in the bleak fields surrounding the C.P.R. tracks on St. Joseph Boulevard in the east end on Saturday afternoon, and proudly buried a toy steam shovel.

"Workers threw hats in the air, cheered and danced as the alderman, once finished with the burial ceremony, announced gravely that 'this action is symbolical of the future policy of the administration in regard to public works destined for the relief of the unemployed.' He added that in most works to be carried out under a $4,800,000 relief works program, hand labor, and no mechanical labor, will be used. 'The worker comes into his own,' he said. 'The steam shovel is buried.' "

The above quotation is from an account of the start of work on a new railway underpass published in the Montreal *Gazette* of Feb. 22.

The toy shovel is buried; but over in a shop in the Lachine section of Montreal stands a real steam shovel lifeless but unburied. It was built in the hope of selling it for use on just such a job as that at which the toy shovel was buried. The builder, failing to make a sale, reluctantly tells some of his men that he will have to lay them off. And nearby is a foundry that makes the parts. It also finds its business dwindling and turns some of its men into the street to seek jobs with hand shovels. Around the corner the grocer, the butcher and the clothier all feel the effect of the lowered spending power of the mechanics upon whom they depend for their livelihood. The falling off of their business, in turn, is reflected in reduced business of the wholesale merchants elsewhere in the city.

All this slowing up of the normal processes of business and all this decline in employment take place right on the island of Montreal. Farther afield it reaches to the steel mills at the Soo, the iron mines at Michipicoten, and the coal mines of Nova Scotia; even the railroads and the food-producing regions of the prairie provinces.

And what of the dollars wasted in moving dirt by hand that could be moved more cheaply by steam shovel? Could they not have been spent to better advantage providing useful work for others elsewhere?

Yes, Mr. Savignac, you buried a toy shovel, but with it you buried the source of the prosperity of your great city. Today you do not see the effect, but next year and the year after, if your shovel-burying policy is continued, there will be no need to construct new crossings under the C.P.R. tracks in order to open up new sections of the city, because there will be no expansion of the city, nor will there be tax money to provide for expansion.

Oil-Processed Road Economics in New Mexico

Conclusions based on records for 500 miles of roads—Traffic capacity, maintenance charges and costs compared with untreated gravel

By William C. Davidson

Santa Fe, N. M., formerly State Highway Engineer of New Mexico

Road surface is thoroughly broken up by toothed scarifiers.

THIS DISCUSSION will endeavor to point out some engineering and economic reasons for the use of oil-processed roads. In doing so, frequent reference will be made to a particular field, New Mexico, where 500 miles of completed construction offers ample opportunity for first-hand study. Some of this mileage has been built for about four years and some of it for slightly more than one year. Excellent opportunity has been furnished, therefore, for observation and study during construction and maintenance periods.

Briefly, the oil-processed road consists of a surfacing of mineral aggregate and a medium road oil. The mixture is accomplished either in place on the road or at a central mixing plant. From these two methods are derived the terms *road-mix* and *plant-mix*. Thus far the road mix method has the wider application. This is probably due to the fact that it was the initial method developed, and to the further fact that it offers economy in construction costs, not yet apparent in the plant-mix procedure. At least such has been the experience in New Mexico where both methods have been used. It is understood, however, that in some of the Western states the cost is practically the same.

Traffic suffers very little inconvenience during construction. Detours are seldom necessary, as travel is permitted to use the road during all mixing operations. When a section of the oiled material has been mixed and spread, it is then ready for immediate use.

General economic considerations

The economic factors considered when adopting the new type were: (a) excessive maintenance of the old gravel roads; (b) medium cost of the oil-processed surface; (c) favorable soil, favorable climatic conditions and abundance of suitable aggregates.

On a large mileage of gravel roads that had been in service for several years the cost of routine maintenance plus the losses of surfacing under the action of traffic were out of all proportion to the service rendered. Either the road must be returned to its original status by the addition of a substantial amount of surfacing, or a higher type must be adopted. Upon analyzing the cost of the two types it was found that the maintenance of the old gravel road plus the annual loss in surfacing plus the difference in car-operation cost was greatly in excess of the cost of the oil-processed road. Preliminary investigation indicated that the proposed new type could be built out of funds available and that the saving made would amply justify the cost.

Another factor that justified the adoption of the new type was the existence of favorable soil and climatic conditions and an abundance of suitable aggregates. The soil was generally sandy and well drained; the rainfall was medium, and the aggregates, siliceous in character, were admirably suited to this type of construction.

Traffic capacities

Observation leads to the opinion that, in a region of medium rainfall and moderately high winds, the economic traffic limit for gravel roads should be fixed at from 300 to 350 vehicles per day. Traffic studies revealed that many of the old gravel surfaces on the New Mexico arterial system were carrying as many as 800 vehicles per day, and an occasional road as many as 1,000 vehicles. Practically all arterial routes of the road system had outgrown the gravel-road standard. It was learned from investigation that a surface of the oil-processed type was adequately handling in other states as many as 1,500 vehicles a day. One case was reported where a road was carrying traffic of 2,500 without excessive maintenance or depreciation. From these data it was evident that this type not only would serve present-day traffic in New Mexico but would provide for substantial increases in the future.

Thus far consideration has been given only to the upper limit of traffic flow. It is seldom that one thinks of a road as carrying traffic too meager for its own welfare. Such was the case, however, on one project built. Here the traffic averaged slightly more than 150 vehicles per day. It was found that this volume was insufficient to keep the surface in good condition. The effect of pneumatic tires upon the surface, except in cases of loadings that caused base breaks, was found to be beneficial, the tendency being to produce a glaze and density at the surface which automatically formed a waterproofing. Breaks in the surface were found in practically every case to be caused from failure of the base due to overloading or bad drainage.

It is an interesting commentary that the class of vehicle most destructive to the oil-processed surface is that which pays no gasoline tax and contributes

Scarified material is broken down to finer particles by harrowing.

Windrows formed of harrowed material are measured to insure even spread depth.

Material spread from windrows is oiled by motor-truck pressure distributor.

in no way to construction or maintenance. This is the horse-drawn wagon of the narrow-tired type. Such traffic comprises only a very small percentage of the total, but it will do more damage to the surface of an oiled road than the combined automotive vehicles. It is especially destructive to the edges of the road, which are broken down under the grinding action of the tires and the breaking effect of shod hoofs.

Building maintenance into design

The state highway department had completed slightly more than 500 miles of the road-mix type as of Jan. 1, 1930. The average cost was $4,000 per mile for a surface 20 ft. wide and 3 in. thick. Many old gravel and crushed-stone bases were utilized as the nuclei of the new roads. These were widened to 22 ft., and the thickness was increased to produce an adequate foundation. The minimum thickness of the finished road was taken at 6 in., including base and top.

What has been the cost of maintenance? On Sept. 1, 1931, state highway department records showed this cost to be $242 per mile per year. This was an average of all projects built and under maintenance.

Generally speaking, the heaviest maintenance costs have developed on roads through irrigated farming districts. This is due to the fact that the groundwater is close to the surface, causing subgrade saturation and failures incident thereto. In addition to the damaging action to the subgrade, the moisture also saturates the oiled mat, with consequent emulsifying and wrinkling. Also horse-drawn traffic, more intensive in farming communities than elsewhere, has a damaging effect.

On one project so situated the maintenance was more than $500 per mile per year. Contract with this figure a maintenance charge of $15 per mile per year on a project favorably situated on a well-drained sandy base where wagon traffic was negligible.

One large item of maintenance has been the reprocessing of many projects on account of rainfall during construction. The moisture contained in the mat may not cause any difficulties for several weeks or even months, but ultimately it will be manifest by a wrinkling and shoving of the oiled surface. The only cure is then to tear up the surface, process it until thoroughly dry and relay it.

By close attention to certain details during construction maintenance costs are reduced. Maintenance should be built into design by providing adequate drainage ditches and proper bases and by keeping the fills well above the groundwater table. Edge failures have taught that bases should extend 6 to 12 in. beyond the outside lines of the surfacing and that the oiled mat itself should be constructed with a thickened edge. By expending slightly more money in the first cost of the road, decided economy will be effected in the upkeep and maintenance.

Maintenance expense can be substantially reduced by thickening the edges of the mat. This is accomplished by cutting a triangular trench 2 in. deep at the outside edges of the surfacing and extending it back 18 in. toward the center, similar to the thickened edges of a concrete pavement. These trenches are filled with the mixed material and rolled to insure compaction. This makes the edge thickness 5 in. as against 3 in. for the remainder of the section. The operation does not add greatly to the cost, and it practically eliminates one of the most costly maintenance items.

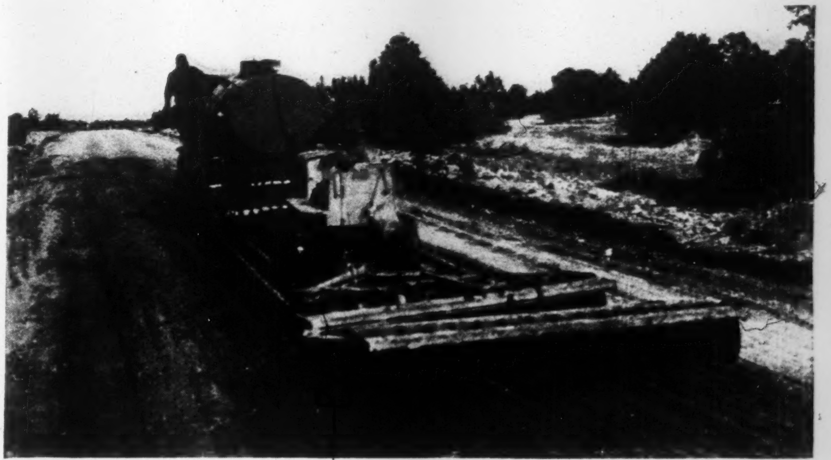
The surface of an oiled road is frequently porous, there being insufficient bitumen to fill all voids. As a result, moisture enters the mat and causes wrinkling, with its attendant maintenance expense. The application of a seal coat of $\frac{1}{8}$ to $\frac{1}{4}$ gal. of oil per square yard will prevent this.

Choice of aggregates

Siliceous materials have proved to be the most desirable aggregate. The maximum size may be $1\frac{1}{2}$ in., although established practice would indicate that the 1-in. maximum is preferable for the reason that this size will permit a smoother finish and a better riding surface. A more stable mat results from the use of angular gravel—that is, gravel reduced to the desired size by crushing.

Thorough laboratory tests are as important in the case of aggregates as in that of oils to be used. Gypsum, caliche and heavy clays are to be avoided. Frequently a visual inspection of an aggregate will indicate whether or not it contains undesirable elements. It is far better, however, to rely upon the exactness of the laboratory to determine the suitability of any material. There is too much at stake to take snap judgment.

The selection of the filler—that is, material passing the 10 mesh—has particular significance. If the tests indicate that its properties are such that moisture will be readily attracted, it



Harrows open up oiled surface to facilitate penetration of oil.

Oil and aggregate are mixed by blading the oiled material back and forth.

should be condemned. Such a characteristic will be evidenced by a high value of the field moisture equivalent. In the treated mat such material spells grief, because it will take up moisture from either the subgrade or the top, with the usual emulsification and wrinkling of the surface. If such a material is used as a binder for the base, it will mean a potential saturated condition, with slipperiness between the mat and base and the subsequent formation of corrugations.

If the laboratory tests show high linear shrinkage values for the filler, this will indicate a heavy, though unstable, soil, such as sticky clay. In the mat such a filler will contribute to cracks and disintegration. In the base it produces a saturated slippery condition, resulting in the delivery of moisture to the mat and ultimate wrinkling of the surface.

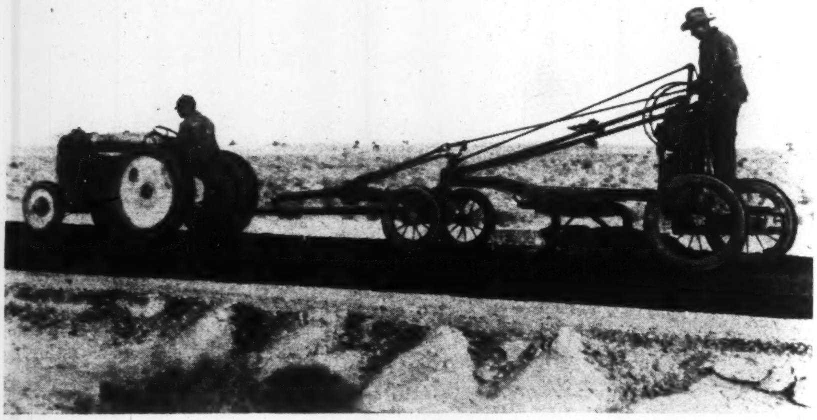
To summarize briefly: avoid any filler that contains high values of field moisture equivalent, linear shrinkage and tenacity, which means any material that is a good vehicle for moisture. On the other hand, low values promise stability of mat and resistance to the ills of moisture. In the sub-base 4 to 6 in. of coarse gravel and sand, with just enough light clay to produce a bond, is of more value than any treatment that might be devised for sealing off bottom moisture.

The density of any oiled mat is increased by using a high percentage, say 10 to 15, of 200-mesh material. Higher percentages of the 200-mesh will require greater quantities of oil, but the resultant mat will have a greater density and will be more resistant to moisture. Furthermore, it will have greater resistance to the action of traffic. Experience in New Mexico indicates that the 200-mesh material should be at least 10 per cent in amount.

Oil requirements

Based on the average of a 500-mile oiling program, the amount of oil used per square yard was 1.76 gal. This varied from a low of 1.22 to a high of 2.36. The difference between these two extremes is accounted for through variation in aggregates. The higher oil content indicates an aggregate with greater amounts of fine material. Another possible reason for this wide difference is the variation in thickness of mats, as it is practically impossible to build all mats to the same thickness. The bases, if not firmly compacted, will yield some loose material that is unavoidably mixed with the oil during construction operations. This will add to the oil requirements.

Original estimates of oil were based on 1.5 gal. per square yard. Gravel supplies used, however, were normally high in material passing the ¼ in. and 10-mesh screens; and since the requirement of the 200-mesh was 10 per cent, the oil required ran somewhat above that estimated.



Mixed material is spread evenly by a tractor-drawn finishing blade.

The amount of oil required for any given aggregate was first determined in the laboratory; but since field procedure and manipulation cannot check the exactness of laboratory calculations, it was necessary to check the aggregates from time to time in the field to ascertain the oil requirements. This was done by carefully screened samples, a plied to the following empirical formu

$$P = (a \times 0.02) + (b \times 0.07) + (c \times 0.15) + (d \times 0.20)$$

where P represents the percentage oil required, in pounds (a gallon weig approximately 8 lb.); a the percenta of gravel, in pounds, retained on the 4 screen; b the percentage of material, pounds, passing the 48 screen and r tained on the 100 screen; c the percent age of material, in pounds, passing th 100 screen and retained on the 20 screen; d the percentage of material, i pounds, passing the 200 screen.

The use of this formula, together wit the practical experience of the field engineer, resulted in the selection of the proper amount of oil. Best results seem to have been obtained where the minimum oil requirements were used. The use of an excessive amount of oil involved extra costs due to the addition of a sand blotting material.

Cost comparisons

Investigation of many gravel roads revealed that the annual loss of surfacing due to traffic and wind was approxi-

Spread and bladed material is compacted and smoothed by rolling.

mately 1 in. Applying this to an 18-ft. surface, the annual loss would be 290 cu.yd. At present contract prices of $1.70 per cubic yard, the annual loss in surfacing material would be $493 per mile. To this figure would be added the yearly maintenance of $350, making a total for replacements and maintenance of $843 per mile per year.

The annual maintenance charge of the oiled road, as determined from the average of 500 miles over an approximate three-year period, is $242 per mile. The initial cost of the oiled surface was $4,000 per mile, this figure also being an average of 500 miles. The interest rate on highway debentures in this state averages 5½ per cent. Highway debentures are now issued for a maximum ten-year period, with an average amortization and interest-paying period of about eight years. This would then require an annual sinking fund of $500, annual interest of $220 and annual maintenance of $242, making a total charge of $962 per mile per year.

But there is another cost factor that must be considered. The average automotive traffic over the system will closely approximate 300 vehicles per day. Therefore, for any given mile of road, the motor-vehicle miles are 109,500 annually. The difference in operating cost between a gravel surface and a bituminous surface has been variously estimated at from 1c. to 2c. per mile. The lower figure will be used in this analysis. For each mile of gravel road converted to the bituminous surface the annual saving in operating costs would be, therefore, $1,095.

The following summarizes the comparison between the two types on the basis of annual cost per mile of road:

Gravel surface: maintenance, $350; replacements, $493; difference in operating cost between gravel and bituminous surfaces, $1,095; total $1,938.

Bituminous surface: maintenance, $242; interest on $4,000 investment, 5½ per cent, $220; amortization charge, eight-year period, $500; total $962.

The difference then in favor of the oil-processed surface is $978 per mile per year. This analysis shows a decided economic balance for the oil-processed road. In addition to the tangible returns as supported by this analysis, there are those other features of pleasure, safety and convenience.

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Lake Union Bridge Provides New Traffic Link in Seattle

Completion of the bridge across Lake Union in Seattle provides an important city and state highway traffic link and represents one of the major bridge projects in the Pacific Northwest. Spanning the ship canal between Puget Sound and Lake Washington, it provides a high-level outlet to the north of the business district, which has been inadequately served by several small low-level bascules with frequent interruptions from shipping. The project was described by T. G. McCrory, chief engineer, department of highways, Washington, in a paper presented at the Tacoma meeting of the American Society of Civil Engineers from which the following summary has been taken. Although the main structure has been completed, the approaches to be provided by the city have not yet been finished, and the structure is not in service.

The main 800-ft. span includes two 325-ft. cantilever arms and a 150-ft. suspended section. Anchor arms, 300 and 350 ft. long, and steel and reinforced-concrete viaduct approaches make the total length 2,955 ft. The project was financed jointly by the state, as a highway link, and by county and city appropriations at a cost of about $2,500,000, exclusive of right-of-way.

The main piers, supporting a load of 8,000 tons each, rest on timber piles. Steel sheetpile cofferdams were constructed and excavated from a floating derrick plant. Bearing piles for these two piers total 1,476, with a maximum length of 124 ft.; they were driven with extension leads to a cutoff depth of 50 ft. below water level.

Tremie concrete poured from a floating plant provided the cofferdam seal at the bases of the piers. Eight tremies were uniformly spaced over the area of each cofferdam so that no lateral shifting was required. After the seal had set for 21 days the cofferdams were unwatered, the seals leveled off and pier construction started. Cofferdam sheetpiling was left in place, cut off near water level and topped with a timber coping to provide pier protection.

Superstructure members made extensive use of silicon and carbon steels. All panels are 25 ft. long, and the trusses are spaced 40 ft. apart. Top-chord members are on a uniform grade of 2½ per cent, corresponding to roadway grade, and all posts and hangers are vertical. Expansion joints are provided at anchor piers and the ends of the suspended spans in the main structure. The main span is supported on fixed shoes and cast-iron pedestals. Erection was carried out with A-frame derrick travelers for the anchor and cantilever arms. Temporary erection bents for the anchor arms were used.

Reinforced-concrete approaches consist of girder spans from 41 to 63 ft. long. Twelve of the fifteen approach spans are located on the north end supported by two-column piers, divided into one-, two- and three-span units between expansion joints.

Foundations for the approach piers consist of reinforced-concrete piles upon which the piers and bents were poured continuously. The extreme height of timber falsework used under the north viaduct was about 110 ft.

The structure is of the deck type throughout, with a 57-ft. roadway, 4-in. crown on the tangent, 16-in. curbs and 5-ft. sidewalks. The vertical clearance is 135 ft. above high water, over a 150-ft. ship channel.

Design and construction were in charge of the Washington highway department, of which Samuel J. Humes is director, T. G. McCrory is chief engineer, and R. M. Murray, resident engineer for the department.

Preliminary study of location and type, as well as the final design, was made in the office of Jacobs & Ober, consulting engineers, Seattle. Principal contracts were carried out by the Pacific Bridge Co., Portland, for the main substructure; N. Nygren, Seattle, for the approaches; and the U. S. Steel Products Corp. for the superstructure.

Main span of Seattle's Lake Union bridge is an 800-ft. cantilever, including a 150-ft. suspended section with 135-ft. clearance. Anchor arms and concrete viaduct approaches make the total length of the structure 2,055 ft

Large-Scale Improvements at Southampton Harbor

England's Southern Railway building long quay of 7,000-ton concrete monoliths sunk by dredging and loading—Earth bank incloses work on largest drydock in the world

EXTENSIVE harbor work under way at Southampton, England, by the Southern Railway, to provide for increasing traffic and especially for steamers of the largest sizes, includes the construction of 7,000 ft. of quay wall composed of huge concrete monoliths and the filling of 400 acres of mudland formerly submerged at high tide. This reclaimed land, behind the quay wall, will be utilized for dock sheds, warehouses, drydocks, railway yards and trackage, and also for industrial sites. A floating conveyor that unloads dredged material from barges and places it in an embankment surrounding the area to be reclaimed is shown in Fig. 1. Present facilities and the new works are indicated in Fig. 2.

A bay on the River Test provided a logical site for the dock extension, which will have a waterfront about 2 miles long. At the west end there will be two drydocks, one of which—the largest ever built—is under construction. The quay wall, with 45 ft. of water, will be 7,000 ft. long, while a future jetty opposite it will increase the length of berthing space to 15,500 ft. The first section of the work, now well advanced, includes half the length of quay wall and 180 acres of filling. Work is in progress on the second section, which will complete the wall and double the filled area. The third section, also under construction, includes the first drydock and the completion of filling. Foundations for the sheds and the building of roadways and railway tracks are in progress. Along the quay a row of passenger and cargo sheds, 150 ft. wide, will be served by tracks, cranes and modern mechanical equipment. Paved roadways will extend behind the sheds on the main quay and between two rows of sheds on the jetty. Connections are made with the Southern Railway at each end of the site and with the tracks of the harbor board at the east end.

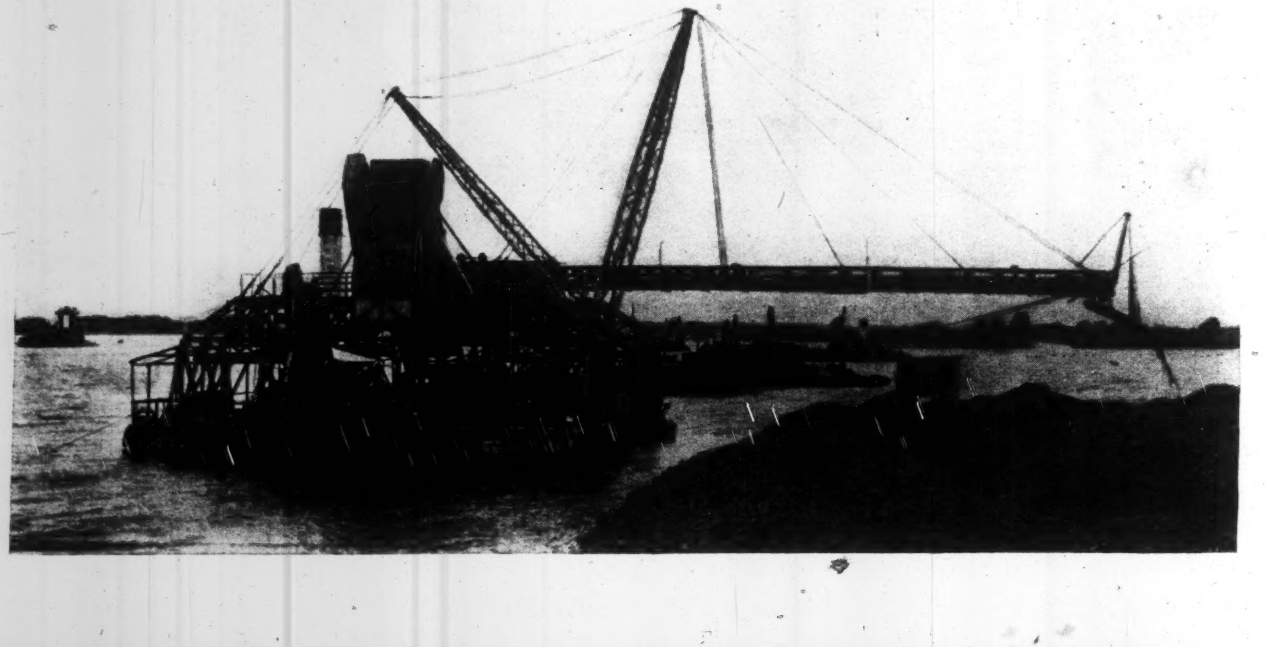
Ship Channels—An approach from the existing deep-water channel to the new quay is being dredged to give 35 ft. of water at low tide for a width of 600 ft., while along the quay and both sides of the jetty there will be 45 ft. of water at low tide. The channel south of the jetty forms also the approach to the drydocks. Opposite the east end of the quay will be a turning basin wide enough for the largest ships, while a swinging basin in front of the drydock will give ample room to handle ships entering and leaving the dock. In the stretch of water between the port and the open sea, a distance of 15 mile where some large vessels have grounde during fogs, a channel is being dredge to give 38 ft. of water at low tide i a width of 1,000 ft. This work, however, comes under government jurisdiction, being ouside the limits for whic the railway company and the city harbor board are responsible.

Dredging and Filling—Materia dredged from the channels and bert space is pumped ashore to fill the reclaimed site. Except for two narrow banks, each about 1,400 ft. long an made of chalk brought from the railwa company's quarries and dumped from temporary trestles, the inclosing embankment is formed of dredged gravel which is also utilized for the concrete Of about 20,000,000 tons to be dredged 7,000,000 tons consists of soft mud that is taken out to sea and dumped 3,000,000 tons of gravel is required for the embankment, and the remaining 10,000,000 tons will be used as filling.

For the embankments the soft mud averaging 12 ft. deep, is first removed and dredged gravel in hopper barges is deposited to about 4½ ft. below low water. Above this level the gravel is placed by a floating conveyor or transporter, as shown in Fig. 1. In this machine two pontoons carry the steel frame with unloading equipment and pipe or conveyor boom, the gravel barges lying between the pontoons. A revetment of brush fascines protects the outer slope of the bank. The main embankment, along the south side, is 167 ft. wide on top to facilitate the building of the quay wall, shown in Fig. 3. After the wall is completed, the bank on its outer side will be removed and a channel 45 ft. deep dredged along the front of the wall.

This long quay wall is composed of concrete monoliths 45 ft. square in plan and varying from 80 to 105 ft. in height.

Fig. 1—Barge of dredged material for fill lies between pontoons carrying unloading machinery in reclaiming operations at Southampton, England, harbor.



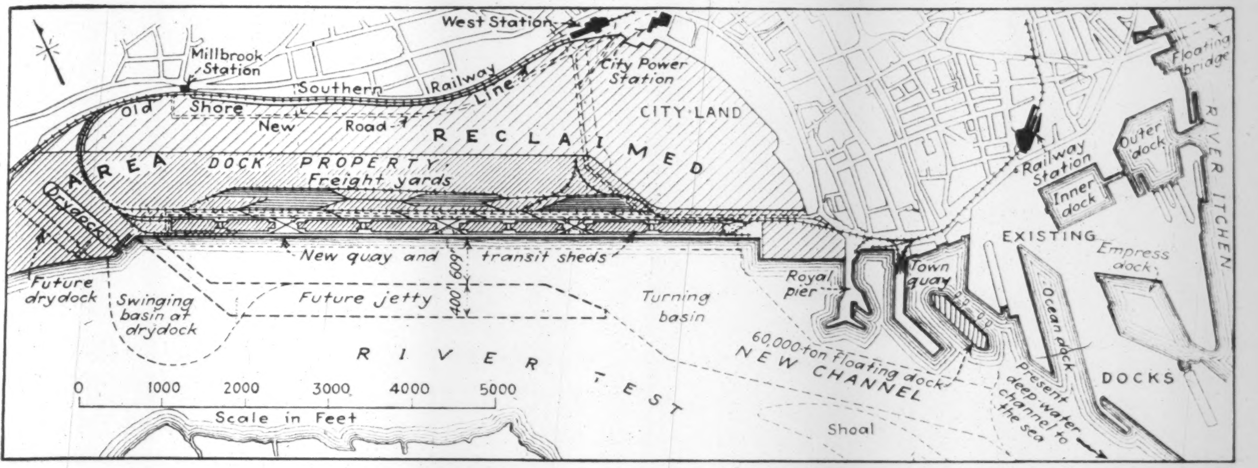

West Station
Millbrook Station
Southern Railway Line
City Power Station
Old Shore
New Road
CITY LAND
RECLAIMED AREA
DOCK PROPERTY
Freight yards
Drydock
New quay and transit sheds
609'
400'
Future drydock
Swinging basin at drydock
Future jetty
Turning basin
Royal pier
Town quay
60,000-ton floating dock
NEW CHANNEL
RIVER TEST
Present deep-water channel to the sea
Shoal
Ocean dock
EXISTING DOCKS
Empress dock
Inner dock
Outer dock
Railway Station
Floating bridge
RIVER ITCHEN
0
1000
2000
3000
4000
5000
Scale in Feet

Fig. 2—Extensive facilities planned and under construction to enlarge port of Southampton, England.

The first section of the wall, 3,800 ft., has 78 monoliths 4 ft. apart, but in the second section there are wider spaces between them. In construction there is erected on the embankment a steel shoe or cutting edge, 45 ft. square and 5½ ft. wide, consisting of V-shaped walls 3½ ft. wide on top and forming nine wells 10 ft. 4 in. square. In and above the shoe the reinforced concrete is carried up 10 ft., leaving wells 10 ft. 4 in. across but octagonal in plan. Above this level the monolith is built up with large precast concrete blocks. Grab buckets operate in the nine wells.

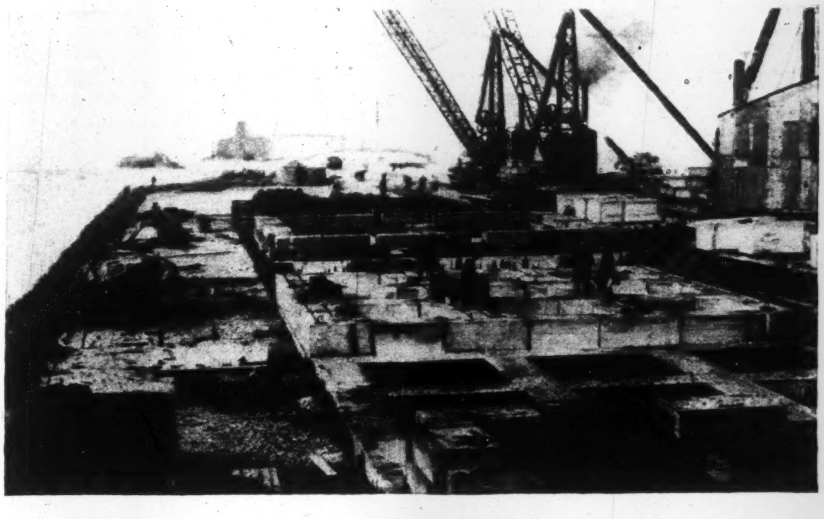


Fig. 3—Hollow concrete monoliths 45 ft. square, for quay 7,000 ft. long sunk through fill by dredging and loading. Brush fascines protect slope of fill.

With the alternations of excavating by the buckets and building up the concrete courses, the monolith is sunk till its cutting edge reaches the necessary depth. Loading with large cast-iron blocks assists the sinking where the weight of the concrete is insufficient to overcome the frictional resistance. Some of the deep monoliths weigh more than 7,000 tons, and in some cases it has been necessary to place a loading of 4,500 tons to complete the sinking. With the monolith in final position, the nine wells are sealed with concrete, and the three rear wells are filled with material dredged from adjoining monoliths. At about 6 ft. below the quay level the wells are covered with reinforced-concrete slabs, above which the quay wall is built up in mass concrete.

Concrete Pipe Culverts—A number of stormwater drains that discharged onto the site have been intercepted by a 7-ft. culvert built in trench along the old shore line. Normally it will give gravity discharge. But to provide for severe storms or high tides, or both in combination, an electrically operated pumping station has been built at the outlet, adjacent to the quay wall.

At the city electricity station (Fig. 2) this culvert is joined by two 7-ft. culverts for the supply and discharge of sea water for condensing purposes. To provide for future increased capacity of the station, these culverts are designed to carry 4,500,000 gal. per hour. An arrangement of valves will enable each culvert to be used for either supply or discharge, and the main drainage culvert will serve as an emergency discharge for the condensing water. All the culverts, aggregating more than 2 miles in length, are of reinforced-concrete pipe, with cement joints and surrounded by mass concrete.

Largest drydock

The drydock now under construction will be the largest in the world, having a length of 1,200 ft., a width of 165 ft. at coping, an entrance 135 ft. wide and a depth of water of 47 ft. on the sill at low tide. A sliding steel caisson forms the gate. Pumps can empty the dock in four hours, even when it contains no ship. The approach will be a channel 600 ft. wide, with a swinging basin 1,500 ft. wide at the dock entrance, both dredged to 35 ft. at low tide.

Two 10-ton electric capstans on each side and a 30-ton electric warping capstan at the dock head will handle the ships' lines or cables in maneuvering. For handling material there will be an electric traveling crane of 50-ton capacity at 110-ft. radius, or 8 ft. beyond the center line of the dock; it will have a 10-ton auxiliary hoist at the head of the boom. On the opposite side will be a 10-ton electric traveling crane with a maximum radius of 60 ft. A light locomotive crane will operate on the floor of the dock for handling bilge blocks and for other purposes.

Prior to construction work on the dock, its site was inclosed by an embankment. To minimize seepage, a 7,000-ft. line of interlocking steel sheeting was driven through the base of the bank and into the subsoil. The lower part of the fill is of chalk from the railway company's quarries; upon this is deposited dredged material, placed by the conveyor plant shown in Fig. 1. While this bank was being built, tidal water was allowed to pass in and out through sluices, which were closed by dropping timber gates when the bank was finished.

Engineers and contractors

These extensive works for improving the railway company's port facilities at Southampton, estimated to cost about $65,000,000 (gold), have been designed by F. E. Wentworth-Sheilds, docks engineer, Southern Railway, and are being carried out under his supervision. All existing works and new improvements are under the direction of G. R. Newcombe, docks and marine manager of the Southern Railway. All these docks and new works are owned and operated by the railway company, while the Southampton harbor board maintains the water approaches.

For the dredging and land reclamation the contractor is the James Dredging, Towage & Transport Co., Southampton; the quay wall is being built by Sir Robert McAlpine & Sons, London, and the large drainage culverts have been completed by Carles Brand & Son, London. For the drydock the joint contractors are John Mowlem & Co., London, and Edmund Nuttall, Sons & Co., Manchester. Some parts of the works will be available for use in 1932, while the drydock is to be completed in 1933. It was planned to have it ready for docking the new 73,000-ton transatlantic steamship for the Cunard Line, but the construction of that vessel has been halted temporarily owing to financial and traffic conditions throughout the world.

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Immense New Water Supply for Paris Authorized

Quarter-billion gallons daily from Loire Valley underground sources to be carried to city by gravity aqueduct

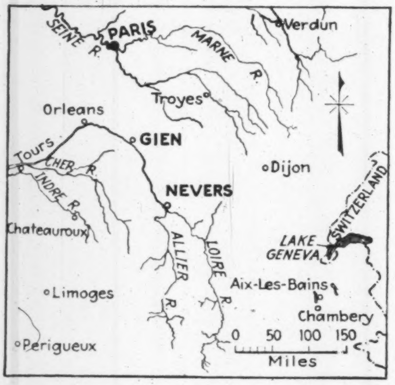
Special Correspondence From Paris

INFILTRATION galleries in the Loire Valley to yield more than a quarter billion gallons of water daily and a 14¾-ft. gravity-flow aqueduct 90 miles long are projected to provide a new water supply for Paris. The project reached the preliminary planning stage late in 1931, was approved by the municipal council on Dec. 31 and has been authorized by the government of France. The estimated cost of the project is about two billion francs ($80,000,000). Detailed plans for the undertaking will be made by M. Sentenac, chief of the water service of Paris, and his staff. The new supply will supplement the "spring water" with which two-thirds of Paris is now supplied, will displace the filtered and disinfected river water that makes up the other third of the supply, and possibly will be served to some of the suburbs. The hardness of the new supply, it is expected, will be only 12 deg., compared with 25 to 30 deg. for the disinfected supply from the Seine. The water from the Loire filter galleries will probably not require disinfection.

The new supply will be taken from a system of filter galleries built in a homogeneous sandy deposit about ½ km. wide and 70 km. long (0.32x43.5 miles), lying on the left side of the Loire, between Nevers and Gien, at such an elevation as to make possible a gravity-flow aqueduct. The filter-gallery system will consist of a central collecting conduit 3.5 m., or 11.5 ft., in diameter at its lower end, fed by lateral infiltration galleries, the main conduit being 8 to 10 m. (27 to 34 ft.) below the surface of the ground. In earlier stages of the project a system of wells and pumps was proposed.

Where under gravity flow, the aqueduct will be of masonry, 4.5 m. (14.76 ft.) in diameter; where under pressure (inverted siphons), two 3-m. (9.72-ft.) reinforced-concrete conduits will be used. The combined length of the main filter gallery and aqueduct will be 215 km. (133.5 miles). The latter will deliver water into a terminal reservoir.

EDITOR'S NOTE—Opposition to the project arose from inhabitants in the Loire Valley, who claimed imperilment of their own water supplies. According to *The Engineer* (London) of Jan. 15, Paris has agreed to build storage reservoirs holding 220,000,000 cu.m. from which in times of drought water will be let down the river.



Filter galleries in 45-mile stretch of the Loire valley between Gien and Nevers to deliver water to aqueduct 90 miles long.

A commission of inquiry made a report some years ago (*Engineering News*, Jan. 22, 1914, p. 167), advising a supply of 250 m.g.d. from wells between Nevers and Briare, with collecting galleries leading to a conduit from which water would be pumped to Paris. The estimated cost was $60,000,000, not including $20,000,000 for distribution in Paris. An alternative project (rejected) was to take water from Lake Geneva to Paris through an aqueduct 300 miles long. Years later (*ENR*, Sept. 13, 1928, p. 399) a company proposed to convey water to Paris from the bend of the Loire.

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Home Community Planning

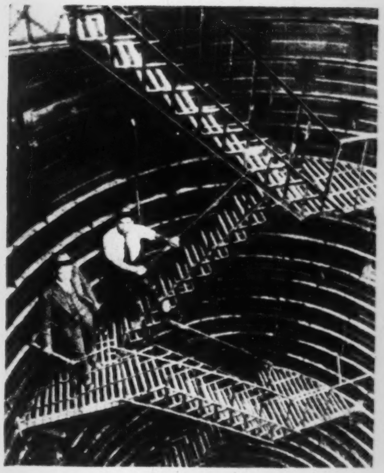
BASIC modern problems of city reconstruction and home community planning were discussed by Clarence S. Stein, architect of the Radburn (N. J.) garden city development, in a recent address at the new School for Social Research, New York City. According to Mr. Stein the unsatisfactory features of past city growth are due partly to the usual rectangular street network, itself an outgrowth of the desire to develop land for maximum profit, and to failure in the planning of home development. Mr. Stein regards the latter as the central point in city building.

Changes in the conditions of living due to improvements in mobility, methods of communication and power utilization find the old city layouts inflexible and inefficient as well as lacking in the amentities of life. In the effort to lead to more modern city development two courses have been followed: zoning for area and use, and planning of major arteries and features of the city (skeleton planning). Neither of these has proved effective in bringing about a satisfactory development protecting home areas. Radburn, on the contrary, is an example of integral or complete planning.

The entire town site was planned as a unit. Homes were grouped about park, garden and playground areas by laying out the land in very large blocks pierced by stub streets or lanes branching from the surrounding public streets. Vehicle and pedestrian traffic is separated. Houses face on the lane with their service sides and have their living quarters facing on the interior park or garden area. Few streets are designed for general traffic, while most streets and the lanes serve local access uses only. Schools, stores and similar central facilities are located with definite relation to the areas they serve. The result is a development of unusually low land cost and of such character that a considerable assurance of permanence of the character of the development is obtained.

Large Steel-Lined Tunnel Shafts Sunk at High Speed

Half a dozen 16-ft. circular shafts for Cleveland, Ohio, sewer tunnel sunk without bracing at rate of 3.2 man-hours per foot of depth

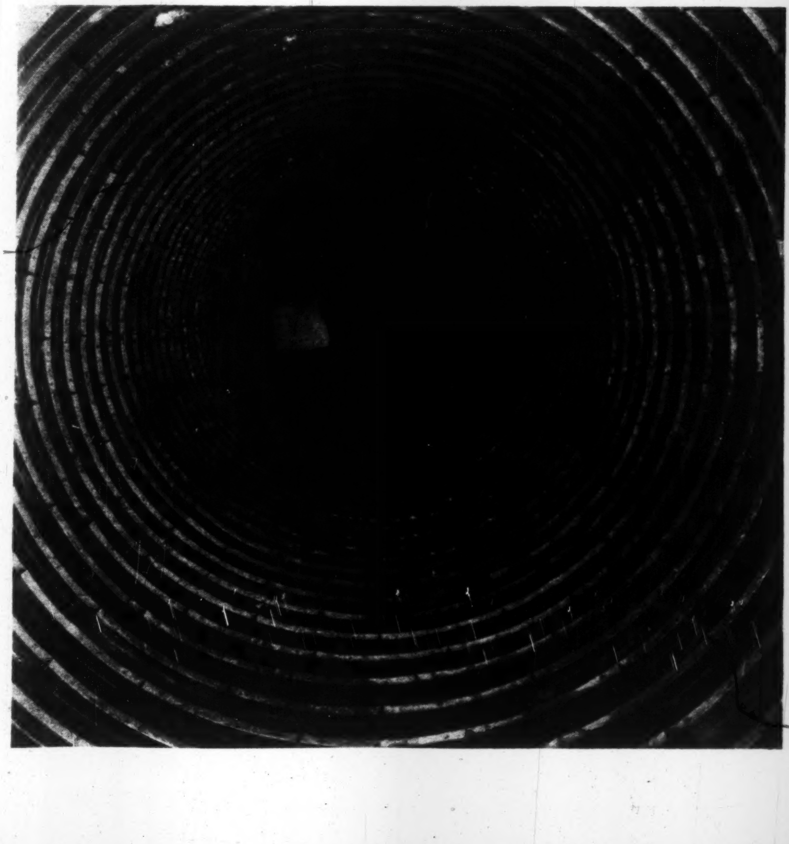


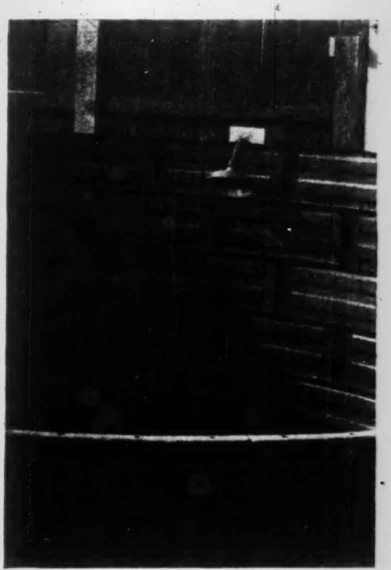
Diameter of 16 ft. and steel lining permit use of fire-escape type of shaft stairway.

THE ORDINARY troubles in shaft sinking in soft ground, particularly where any quicksand has to be penetrated, were avoided with remarkable success in sinking a half-dozen working shafts for sewer-tunnel construction in Cleveland, Ohio. Flanged plates were used for lining the shaft, without timbering or bracing. The size of the plates, 16x37$\frac{11}{16}$ in., permitted them to be installed, one at a time, in rings proceding from the top downward, with so little exposure of unsupportable shaft wall at any one time that sloughing was easily controlled. When bolted tight, with a joint filler in particularly wet strata, the plates virtually sealed the shaft as fast as they were installed. With the plate lining completed, the entire interior space of the shaft was open for working operations and equipment.

The shafts for the sewer-tunnel work were of unusual diameter (16 ft.) considering their moderate depth of 60 ft. and the size of tunnel, which is for a 5-ft. circular brick sewer. This large diameter was adopted solely to prevent crowding of shaft equipment and bottom operations. With a hoisting cage frame in the middle, the 16-ft. shaft gave room to install regular fire-escape-type stairways and any amount of shaft piping that might prove necessary if water, ventilation or compressed-air-supply problems should develop. Although the conditions encountered developed requirements for little other shaft equipment than hoisting cage and stairway, the large shaft space is considered by the contractors to have proved its worth in greater freedom of working operations and convenience for the workmen. The views show clearly the ampleness of shaft room sought and obtained by the large diameter and unbraced interior.

Shaft sunk 60 ft. through soft ground in 192 man-hours, using unbraced steel liner plates.





Steel liner plates have embossed panels to stiffen web against heavy earth pressures.

The sinking of the shafts was especially notable for its speed. Clamshells took out the material except around the edge, where it was cut down by hand as the liner plates were inserted one after another in a circular ring. In firm soil the wall could be cut down and would stand up long enough for easy plate setting, but in the quicksand layer the plates had to be more or less worked into place by digging out a place for one plate at a time. No material difficulty of plate placing was encountered in any soil, as is evidenced by the fast work done. In the case of the shaft illustrated the excavation and lining were completed 60 ft. to the bottom in 192 man-hours; other shafts were sunk in comparably short times. In the shaft illustrated a 6-ft. layer of quicksand was passed through at a depth of 30 ft.

The shafts were sunk by the Cogito Construction Co., Cleveland, Ohio, the contractors who are building the 5,600 ft. of tunnel on which the shafts are located.

Erecting 3,800-Ton Bascules in the Arlington Bridge

Movable span in this monumental structure at Washington, D. C., one of heaviest in existence, made to harmonize with adjacent masonry arches by masking the trusses with ornamental sheet metal

By R. S. Foulds
Assistant to General Manager,
The Phoenix Bridge Co., Phoenixville, Pa.

THE MOVABLE SPAN of the Arlington Memorial Bridge over the Potomac River in Washington, D. C., is one of the largest and heaviest bascules in the world. With an over-all width of 96 ft., including a 60-ft. roadway and two 14-ft. sidewalks of reinforced concrete, each of the two 108-ft. leaves and its concrete counterweight weigh 3,800 tons. Design, fabrication and erection consequently involved difficult problems.

The design of the Arlington Memorial Bridge was governed largely by architectural considerations. In appearance it is a nine-span arch bridge, but it actually consists of eight concrete barrel arches of 166- to 180-ft. spans and the 216-ft.-span bascule in the center, which is faced with ornamental metalwork to harmonize with the white granite facing of the arches. The substructure of the bridge consists of four abutments, one at each shore line and one at each end of the bascule span, and six piers. The total length of the bridge is 2,143 ft.

Bascule design

As shown in the accompanying illustrations, each leaf includes two bascule trusses mounted on a main trunnion resting in bearings either side of the truss. The bearings are carried on vertical trunnion posts that transfer the load directly to the abutments. The counterweight under the floor hangs as a pendant from counterweight trunnions at the rear end of each bascule truss, the arrangement being such that the counterweight moves parallel to itself as the leaf rotates upon the main trunnions. At the center of the span the two leaves are locked together by a detail designed to transmit shear and to maintain equal deflection for both leaves under all conditions of loading.

Each leaf is operated by two motors direct-connected to a herringbone-gear speed-reducer, which, through a self-contained equalizing device, delivers one-half the driving torque to each of the two main operating pinions, meshing with rack segments attached to the bascule trusses. Each operating motor is provided with a motor-mounted solenoid service brake. The intermediate shaft of the speed reducer is extended on each side to take two emergency solenoid brakes (four in all), which may be applied one at a time and are of sufficient capacity to hold the leaf fully open against a wind pressure of 15 lb. per sq.ft.

Power service at the bridge is in the form of alternating current, three phase, 60 cycle, 4,000 volts. A 4,000-volt, 300-hp. motor is direct-connected to two 100-kw., 600-volt d.c. generators, which supply current to the operating motors. The arrangement is such that the operating motors of either leaf can be supplied with power from either generator.

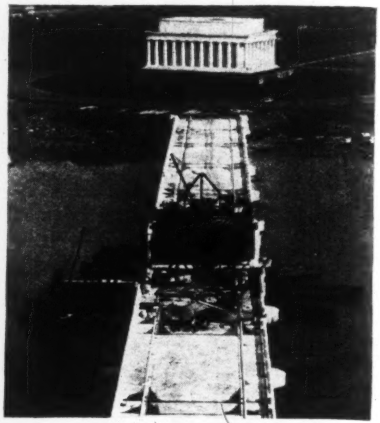


Fig. 2—Double-leaf bascule span at center of Arlington Memorial Bridge, Washington, D. C., erected by two stiff-leg derricks and a floating plant. Lincoln Memorial in background.

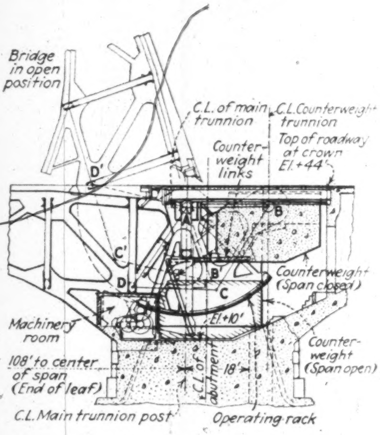


Fig. 3—Concrete counterweights, weighing about 2,400 tons each, move downward into a pit under the bridge floor when the 108-ft. leaves are raised.

The speed of leaf operation varies directly with the voltage, so that it is possible to combine a high motor torque with an extremely slow creeping speed for seating the bascule leaves. A gasoline-engine-driven generator set has been provided for use in case of failure of the regular power supply.

Bascule erection

The approaches to the bascule span were not complete when its erection was started, so that all materials had to be delivered by water. A contractor's yard was established and materials were received in the government reservation on the Arlington side of the river. A derrick car and cranes in this yard transferred materials to barges, on one of which an A-frame derrick was installed. From the yard to the site was one-third of a mile, and a tugboat moved the floating equipment between the two places. At the bascule site a 30-ton steel stiff-leg derrick was installed on each abutment, and materials were placed by these and by the derrick boat.

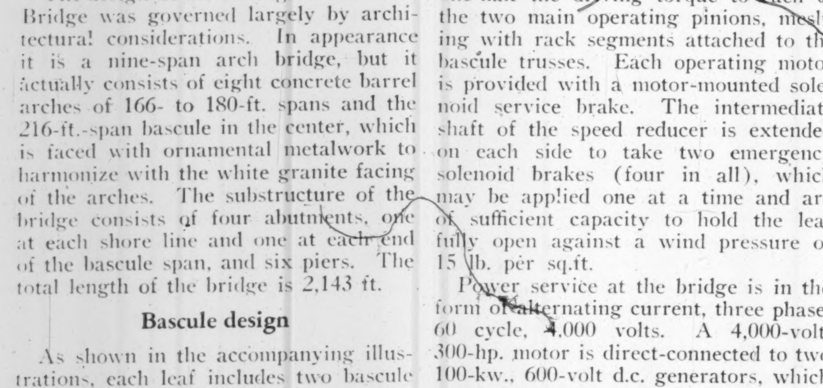


Fig. 1—The 108-ft. Washington leaf, after completion, was raised to provide a shipping channel while the Virginia leaf was under construction. The ornamental metalwork fascia on the bascule is painted to harmonize with the granite facing of the adjacent concrete arches.

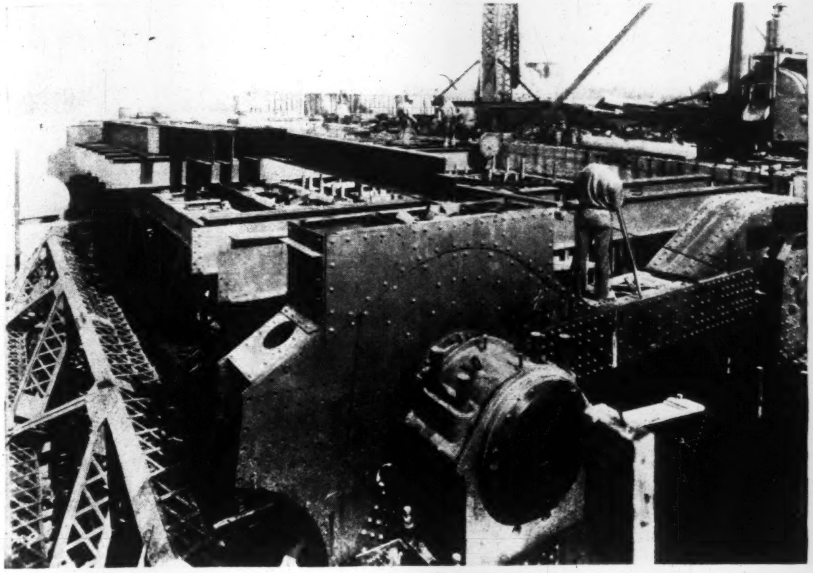


Fig. 4—Massive main trunnion and counterweight trunnion of Arlington bascule. Assembly of two main-truss members, gussets and trunnion pin comprised an erection lift of 31½ tons.

As the initial erection operation, the grillages under the trunnion posts and the trunnion bearings resting on the posts were set with extreme care. Before grouting the grillages they were leveled by set screws. Dowels of 1¼-in. size and 1½-in. set screws were used for locating and adjusting, and dummy trunnions with a taut wire through their axes were utilized in aligning the trunnion bearings before planing and inserting the necessary shims. The distance between trunnion axes on opposite abutments was carefully measured to insure proper matching of the leaves at the center of the channel. Machinery supports also were placed with great care. The trunnion posts were among the heaviest single lifts, each section weighing 22 tons. After these and the bearings were placed, the rear portions of the main trusses and the heavy counterweight truss suspended between them were built. The heaviest single lift in the bridge weighed 31½ tons and comprised an assembly of the two main-truss members and the gusset plates connecting them at the trunnion, the trunnion pin and the collars.

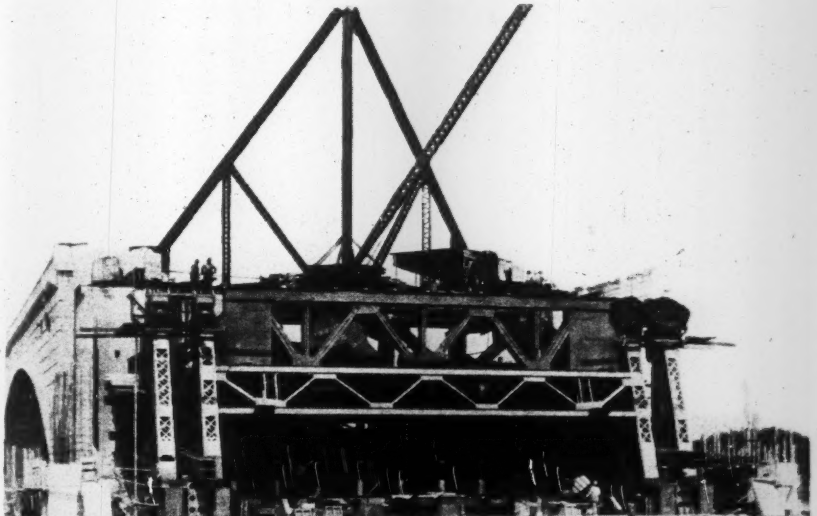
Counterweight—Steel falsework resting on the pit floor was erected to carry the mass of the counterweight, dimensions of which were approximately 16x25x66 ft. Three-inch planking on the falsework beams served as the bottom forms. The timber side forms were built in sections in the Arlington yard ready for assembly at the site.

The volume of each counterweight is 689 cu.yd. The weight per cubic foot required for the Washington leaf was 265 lb., and for the Virginia leaf 255 lb. (The center locking device on the Washington leaf accounts for the greater weight of its counterweight.) To secure the above unit weights, punchings were specified to be used in the concrete mixture. Although structural shop punchings are more satisfactory as a concrete ingredient than other forms of steel scrap, the counterweights on this bridge would have required about 3,000 gross tons of punchings—an amount too large to be accumulated from all the available sources in the time allowed. To solve this problem, an effort was made to secure a material of high specific gravity as a substitute. Consideration was given to "heating-furnace cinder" (lump of Fe_3O_4 obtained from heating furnaces), copper slag and various ores. Some ores, while having the high specific gravity, proved friable and unfit. Chilean ore was found to be a good substitute but unfortunately was not available. The solution was to use Swedish ore, which had satisfactory physical characteristics and a specific gravity of 4.94. The entire cargo of a ship from Sweden (2,400 gross tons) was secured and transferred by rail (59 carloads) to the Arlington yard, where it was run through a crusher to break up the lumps, and then transported to the concreting plant on the bascule abutments.

Compression tests of concrete specimens containing Swedish ore showed the strength to be entirely satisfactory, and the materials were accordingly proportioned to get the desired unit weights. Included in the counterweights as mixed are 2,200 bbl. of cement, 125 tons of sand, 910 gross tons of fine Swedish ore, 1,490 gross tons of coarse Swedish ore, and 1,136 gross tons of punchings. About 146 tons of water is retained in the mixture. Exclusive of reinforcing rods, the total mixture in the counterweights weighs 4,787 tons. All materials necessarily were proportioned by weight. In placing the concrete, a compacting machine was tried but proved impractical because of the large amount of reinforcing steel.

The program of construction called for erecting one leaf of the draw at a time, to permit placing the concrete floor slab with the leaf closed. To protect navigation, a fender 8 ft. wide and 143 ft. long was built in the center of the opening, and temporary fenders were built around the abutments. When these fenders and the Washington counterweight were completed, navigation was restricted to the south half of the channel. The main trusses, the masking

Fig. 5—Trunnion posts are braced by a heavy transverse truss over counterweight pits. On the left trunnion post is the dummy trunnion used in aligning the trunnion bearings.



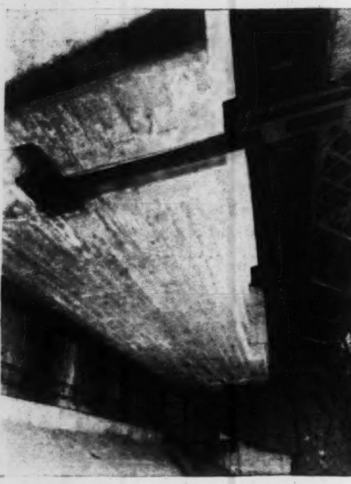


Fig. 6—Pit into which counterweight lowers when span is being raised. View gives indication of huge proportions of concrete counterweight.

trusses and all bracing for the Washington leaf were erected by the derrick boat. In this part of the work the heaviest single lift was the 26-ton end floor beam over the center of the channel. When all but the bottom-chord splices of the trusses had been riveted, forms for the roadway and sidewalk floor slabs were installed and the concrete was poured.

Before opening the leaf it was necessary to apply the copper-molybdenum metal to the masking trusses and to place and adjust the cast-aluminum balustrades on the deck. The installation of the machinery and power line proceeded along with the other work. When the leaf was raised it was found to balance excellently.

The construction of the Virginia leaf was carried out in a similar manner with navigation diverted to the north half of the channel.

The Arlington Memorial Bridge commission had charge of the entire project. For the commission Col. U. S. Grant, 3d, is the executive officer, and John L. Nagle is designing engineer. The Phoenix Bridge Co., of Phoenixville, Pa., had the general contract for all the work on the bascule span. The Faucus Machine Co., Cleveland, Ohio, had the subcontract for furnishing the machinery, and the Phoenix Bridge Co. erected it. W. V. Pangborne & Co., Inc., of Philadelphia, had the subcontract for the electrical equipment. The Hunkin-Conkey Construction Co., Cleveland, Ohio, had the subcontract for the stone-masonry finish and concrete backing for the abutments, as well as for the concrete for the houses and the floor slabs. The Strauss Engineering Corp. (C. E. Paine, managing engineer) was engineer for the bascule span. For the Phoenix Bridge Co., J. F. Kinter, superintendent of erection, was in general charge, and field operations were under H. A. Archinal, foreman, and Frank Peirce, resident engineer.

Surveys Record Data on Sewer-System Hydrology

By V. W. Willits
Assistant in the Bureau of Engineering, Los Angeles, Calif.

TO PROVIDE records showing the relation of sewer use to sewer capacity and information for programming extensions, Los Angeles has deevloped a system of surveys and recorded data during the past eight years. These surveys are based on field observations and provide statistics and material for a series of maps, giving immediate information on any phase of the sewer systems's use and its excess capacity.

Data Collected—The rate of flow in second-feet at various strategic points in the system is gaged at regular intervals to provide information including: (1) excess capacity and increase in flow since previous records were taken, correlated to population or industrial increase as a guide to future service; (2) position and cause of defects or clogging; (3) coefficients of quantities per capita or per acre in accordance with various conditions of topography and population; (4) time of arrival of peak loads from laterals to trunk lines; (5) comparison of actual performance with design; (6) influence of stormwater, and industrial waste, such as from packing houses and laundries; (7) silt and sand deposits; (8) measurements at outfall for information on entire system; (9) analysis of pumping plant data; (10) data for periodic billing of foothill municipalities for ocean outfall service.

Method—Gaging is done at existing manholes where the depth of sewage measurement permits the computation of flow at the station by reference to hydraulic properties of pipe diameter, grade and rating curve. The manholes selected for periodic gaging points total about 850 and have been carefully selected for the following characteristics: (*a*) critical position near outlet of a trunk or below or above junction of laterals; (*b*) uniform diameter and slope; and (*c*) accessibility, including freedom from heavy traffic on street, lack of offsets and depths preferably less than 15 ft.

Field parties, consisting of a chainman and two laborers with transportation, work under the direction of an assistant engineer. Measurements are made from rim to flow line and the time noted. In an average eight-hour day one of these parties can observe the depth and time of peak flow through eight or ten connected manholes. In special cases of heavy storms or industrial plant discharge, 24-hour runs are taken. A depth-gage with clock recorder is used if conditions are favorable.

Pumping Plants—An important fe ture of this survey and the resultin data is the information obtained fro sewage-pumping plants. The usual sta tistics kept by a pumping plant includin Venturi meter graphs, pressure gag records and meter readings are sufficien except in special cases. Observed lift pressure heads and power output in dicate the power used in the plant. Fo smaller plants not equipped with record ing instruments, portable water gag meters are attached for periods of te days every three months for chec purposes.

As measurements are based on th depth of flow and corresponding propor tional discharge to full sewer capacity all reference in books and diagram refers to full pipe capacity at existin grade. In special cases of discharg various hydraulic problems arise in computing capacity. Statistics are as sembled by drainage basins (except out falls and interceptors) progressing from a junction with the trunks through laterals and tributaries. Notes and data are entered on a card reference system cross-indexed for convenient reference.

To make this information available for rapid inspection and interpretation by city engineering and public officials, exhibit diagrams and maps are maintained showing summaries of collected material. Maps on 1,000- or 2,000-ft. scales in standard 30-in. sheets show: (1) sewage lines with full pipe capacities in black and colored figures to indicate maximum second-feet flow observed for each year since 1921 at gaged manholes; (2) location and length of pipes overloaded at the end of each year; (3) stormwater increment with wet-weather discharge together with dry-weather flow at special gaging points to indicate amount of stormwater and ground infiltration; and (4) special profiles and exhibits of overtaxed portions of trunk line giving monthly records of flow, storm observations, silt deposits, etc. In connection with these exhibits information service is maintained which is particularly useful in studies for improvements and extensions and the issuing of permits for laundries, swimming pools and the like.

This survey work is carried on by the part-time supervision of an assistant engineer, the full time of two junior engineers and one draftsman, part time of one surveyor and full time of two surveyors' helpers.

Detail development of this program has fallen largely to the writer under the supervision of Walter D. Smith, assistant engineer, and H. G. Smith, division engineer. J. J. Jessup is city engineer.

Financial Embarrassment of Cities and States

Newark and Atlanta cut budgets after long resistance to bankers' demand—Bond sales and failures from coast to coast

IN CONTINUATION of the notes on the financial embarrassments of municipalities given in *ENR*, Feb. 25, p. 274, happenings at Newark, N. J., and Atlanta, Ga., are here recorded, together with reports on successful and unsuccessful sales of bonds.

On a smaller scale Newark has been going through much the same experience as New York. In normal times it has no trouble in borrowing money in anticipation of taxes. Like other New Jersey cities and cities generally throughout the country, Newark pays taxes to the state, and, having a large part of the taxable wealth of New Jersey, it gets back a large percentage of them in refunds for local use. Instead of paying directly to the state, it pays through the county in which it is located. So do 21 other municipalities in Essex County. Many of these places, including Newark, became short of funds early this year, could not pay their state taxes and thus did not get their refunds.

Newark and New York bankers insisted on a "balanced budget" at Newark, impossible without retrenchments and scarcely possible then without cuts in city salaries. But the police, the firemen and the teachers (and other employees also) have their salaries protected by state legislation, and for this reason, together with political expediency, salary cutting was given up after attempts to get these protected classes of employees to accept pay cuts.

Other expedients of retrenchment were found a few weeks ago that were pleasing enough to the bankers and to local insurance companies to enable the city to sell notes and pay its state taxes and meet pressing short-time paper. On Feb. 19 the mayor announced the renewal of $4,100,000 temporary bonds, but for one month only, at 6 per cent against the original 2½ per cent.

All seemed plain sailing for Newark, but it soon struck another financial snag. This arose through the offering on Feb. 23 of $5,000,000 of improvement bonds, due 1933-72. The officials thought they had assurances from a syndicate of local and New York bankers that 6 per cent bonds would be taken at par. But instead of making a bid the bankers asked for more data on the financial condition of the city. The next day an ultimatum for further budget cuts was received, to bring the total slash up to at least $2,000,000. The demand came just after the commission had adopted the budget and fixed the tax rate for 1932. The combined appropriation for the city and the school board was $968,000 under last year. The commission declared that no further cuts could be made and adopted a budget on Feb. 24. The bankers still held out but compromised on $532,000 additional cut, making $1,500,000 altogether instead of $2,000,000. Besides this the commission added $100,000 to anticipated revenue, promised not to make any new capital outlays this year, to revise water rates and to live within anticipated revenue. On Feb. 26 the budget was reopened, amended as stated and passed. On the same day, a group of eighteen Newark and New York bankers bought $5,000,000 6 per cent bonds. On Feb. 29 these were sold to the public: $360,000, 1933-35, to yield 6 per cent; $4,640,000, 1936-72, to yield 5.75 per cent.

While Newark was struggling with its budget and the bankers a number of projects designed to give it and other New Jersey municipalities relief were before the legislature, civic organizations and special commissions. The only specific accomplishment up to Feb. 24 was an act enabling municipalities to receive tax payments quarterly instead of twice a year, thus lessening the sums to be borrowed in anticipation of taxes.

Atlanta forced to cut pay

Atlanta has had its run with the bankers over retrenchments in appropriations and with its civil servants over pay cuts as a part of budget reduction. The bankers insisted that the cost of running the city must be reduced and the budget balanced. The city legislature was loath to cut pay and after seemingly giving in attempted to squirm out by means disapproved by the city controller, the mayor and the bankers. The mayor made himself so unpopular with local union labor that the latter circulated a petition for his recall—and, curiously enough, obtained more signatures in a few weeks than the anti-prohibitionists had been able to get in much longer time on a recall petition.

After weeks of backing and filling by the city council a budget was adopted (signed by the mayor Feb. 15). Under it all city employees work unpaid 10 per cent of the time, beginning Jan. 1, besides which there were "drastic cuts in all departments." In a sense, the pay cuts were not retroactive because payrolls back to Dec. 15 had not been met. On Feb. 19 some 4,000 employees were paid a total of $600,000. Of this sum $365,000 was obtained from bankers and the remainder from current funds, almost emptying the treasury. Neither 1931 salaries nor unpaid bills could be legally financed by the bankers, their attorneys advised.

The operations just outlined did not include the board of education, whose budget was still pending. For weeks the board had been as loath as the council to cut salaries, although it has reduced its appropriations by nearly $200,000 compared with 1931, chiefly by omitting all items of capital outlay and reducing maintenance items. Meanwhile the local teachers' association, partly to head off proposals for reducing the length of the school year, had voted not to resist pay cuts up to 10 to 16 per cent. On Feb. 22, the school board, by a vote of 7 to 5, passed a resolution providing for a 10 per cent cut in the pay of all its employees and calling on its administration department "to cull an additional $215,000 from school expenditures." The superintendent recommended, among other things, that the kindergarten, night and "opportunity" schools be closed, at a saving of $120,000; but the latest reports indicate that the board finally accepted the teachers' offer of 10 to 16 per cent cuts instead.

Bond sales and failures

A number of failures to sell city notes and bonds were recorded in the last week's article (*ENR*, Feb. 25, p. 277) on the financial plight of many of our cities. Included in the list was the city of Buffalo, which on Feb. 10 received no bids on nearly $4,790,000 of notes and bonds. On Feb. 24 these securities, at a higher interest rate, were sold to a couple of banking groups: one took $1,790,000 of 5 per cent general improvement bonds, 1933-52, at 100.606; the other took $3,000,000 of three-year 6 per cent home relief paper, at par.

Camden County, N. J., received no bids Feb. 24 for $500,000 road, bridge and institution bonds, due March 1, 1934, although an interest rate up to 6 per cent was permissible.

Atlantic City, N. J., had no bids Feb. 26 for $1,955,000 tax revenue bonds due in August; 6 per cent permissible.

Erie County, Pa., sold $600,000 5 per cent 1948-52 bonds, callable in 1942, to a syndicate at 100.2856.

Mississippi had no bids on Feb. 24 for $2,500,000 three-month notes, 6 per cent permissible.

Cuyahoga County, Ohio, received no bids Feb. 23 on $224,000 renewal road bonds; will try private sale.

Saint Louis County, Mo., sold a new issue $1,500,000 of 5 per cent road bonds 1937-52, at 98.165 to a syndicate in competition with other bidders.

California had no bids Feb. 23 for $1,325,000 4½ per cent 1933-44 veterans' welfare bonds (bids limited to par value). The bonds were the unsold part of a $6,000,000 issue offered Dec. 17, the reduction in amount having been effected chiefly by "over the counter" sales.

Highway Engineering and Its Relation to Accidents

The road as a safe engineering structure demands greater consideration as a factor in accident occurrence than do driver practices

By Harry Tucker

Professor of Highway Engineering, North Carolina State College, Raleigh, N. C.

MANY STATES have central agencies for collecting information relative to traffic accidents. Some of them use a common method of tabulating and reporting this information. But at the present time it is not possible to secure these data in accurate form for all of the states. For a study of the major causes of highway accidents the percentage tabulation prepared by the Travelers Insurance Co., Hartford, Conn., covering accidents for 1930, seems to be the best available. A comparison of these data with a similar percentage tabulation covering North Carolina, in which state a standard method of reporting traffic accidents has been adopted, shows a substantial agreement. For the study undertaken in this article, therefore, the traffic-accident data for North Carolina will be used because it represents average conditions prevailing over the United States, and also because the state highway system has been constructed in accordance with heretofore satisfactory standards of good highway location and design.

The location, design, construction and maintenance of a highway are often factors contributing to highway accidents, though rarely given in reports of such accidents. Thus, insufficient sight distance may be responsible for an accident, though there is no space on the standard form for this purpose. The same thing applies to a sharp curve, a narrow bridge, a blind intersection and many other features of road location and design that result in fatal accidents. It is rather difficult, therefore, to determine exactly how far the elements of location and design do contribute to traffic accidents. The best that can be done is to take the accident data available for those factors and consider that they represent only a part of the road conditions that are responsible for accidents. Thus, in North Carolina for 1930 we have the following highway traffic data covering fatal accidents:

	Per Cent
1. Action of Pedestrian Involved in Accident:	
Walking on roadway	21.6
Crossing street or highway	22.3
At work in roadway	5.0
Playing in street	20.0
All others	31.1
Total	100.0
2. Violations of Motorist:	
Passing car on curve on hill	1.6
Driving off roadway	7.0
On wrong side of road	6.5
Exceeding speed limit	20.0
Cutting in	3.0
Reckless driving	11.0
All others and not stated	50.9
Total	100.0
3. Road Location Involved:	
Between intersections	8.9
Rural intersection	2.8
State highway, straight road	56.4
Street intersection	5.6
Railroad crossing	5.3
Curve	13.6
Bridge	2.8
All others	4.6
Total	100.0
4. Railroad Crossings:	
Man on duty	2.6
Automatic signals	5.2
Unguarded crossings	46.2
Not stated	46.0
Total	100.0

Frequent reference will be made to these data in the following discussion. A superficial examination of the data indicates that the location and design of highways are not greatly involved in highway accidents. But again it is pointed out that the accident data do not present the true facts, and give only a small part of the percentage of accidents in which the design and location of the highway are contributing factors.

An analysis of highway traffic accidents shows that speed and reckless driving are responsible for nearly 60 per cent of the fatal accidents in which the motorist was at fault. This would indicate that many motor vehicles are operated at too high speed for safety. But the tendency is to increase speed limits for both private and commercial vehicles irrespective of road conditions, the type of drivers and the mechanical condition of the vehicle. If it is necessary, then, to continue to speed up traffic, the mechanical conditions of cars must be even more perfect, the unfit drivers eliminated through strict license laws, and the roads located and designed with more thought to the safe operation of motor vehicles over them. If speed, then, is desirable, highway engineers, for their part, should locate, design and construct roads in such a way that traffic hazards will be reduced and speed can be indulged in with safety.

Location

Grades, alignment and intersections are the factors in the location of a highway that determine the degree of safety with which it can be used. A general rule those maximum grad that will permit of the economical operation of vehicles will also prove satisfactory from the standpoint of safet Exceptions will occur in grade-separation locations, in the approaches t bridges and in grades leading to fills th are constructed on sharp curves. Th committee on road design of the American Association of State Highwa Officials recommends that the maximu grade for grade separation shall not b more than 5 per cent. This shoul apply, if at all, only on straight approaches, and it should be considerabl reduced for sharp curves. It is possibl that some grade-separation structur have been so located and designed th they are even more hazardous than th grade crossings.

The accident data cited above indicate that 24.5 per cent of highwa accidents were reported as occurring o curves, at bridges, at railroad grad crossings and at rural intersections. Remembering that this probably represent only a part of the hazards that resul from faulty road location, it is sufficiently impressive to point out a need for the location of highways so as to reduce the hazards from these sources. For safety in the operation of modern motor vehicles it is essential that the maximum degree of curves be considerably reduced below the standards that have been adopted in many of the states and counties. Thus, the committee report referred to above recommends that the maximum degree of curve shall not exceed 5. This is certainly a reasonable standard for level and rolling topography and should only be exceeded in mountainous country when the cost of construction would prove excessive. For high-speed traffic this maximum should, in all probability, be reduced to 2 deg.

It is not always practicable to locate the approaches to bridges, grade crossings and grade-separation structures so that traffic hazards from location alone are entirely eliminated. But if more thought is given to the *safe* use of the road, it will be found that slight changes in location will reduce traffic hazards without greatly increasing cost. Particular efforts should be made to limit the degree of curve and the maximum grade of the approaches. For all of the cases cited tangent approaches are desirable, and sufficient sight distance should be provided so that the nature of the structure can be foreseen by a driver unaccustomed to the road.

Rural-highway intersections are sometimes located with a total disregard of safety considerations, especially if the intersecting road is relatively unimportant. Blind intersections may be found on some of the heavily traveled state routes. Many of these can be made much safer at a small cost either by relocation or by removing obstructions.

Minimum sight distances of 500 ft. for main highways and 250 ft. for secondary roads have generally been adopted by the several state highway departments. Even if these standards were strictly adhered to, they would not be sufficient for modern high-speed motor traffic. A clear view of the road for 600 ft. is essential for two vehicles approaching each other at 60 miles per hour. For the secondary roads the sight distance should not be less than 40 ft.

Design

The design of the cross-section of the highway, together with the width and type of pavement, materially affects the safe use of the road. The distance c. to c. of ditch should be sufficient for shoulders of ample width, certainly 8 ft. or more, permitting the parking of a vehicle entirely off the pavement when necessary. The slope of these shoulders should be flat enough so that motor vehicles can be brought back onto the pavement with convenience and safety. It is well to point out that laws or traffic regulations in some states require that vehicles when parked must be entirely off the pavement. This is surely a wise provision, but often the shoulders are so narrow and in such a condition that it is not possible to park a large motor vehicle on them.

The pavement on a main highway should have a width of not less than 10 ft. for each traffic lane. The increase in number, dimensions and weights of commercial vehicles makes this provision necessary. The type of pavement should preferably be one that is non-skid, and one that permits a blending between the pavement and shoulders, so as to eliminate, as far as possible, the formation of the dangerous rut along the edge of some hard-surfaced pavements.

Pavements should be both elevated and widened on curves. The report of the committee on design, which has been referred to above, recommends that superelevation be in accordance with the formula

$$E = 0.067 \frac{V^2}{R}$$

in which E is the elevation per foot of width, R the radius of the curve, and V is taken as 35 miles per hour. If the formula is used for curves of short radius, the resulting superelevation will be too great. But for main highways with curvature limited to 5 deg. it gives satisfactory values. But irrespective of the formula used, the point is that curves should be banked so that cars can traverse them with a minimum tendency to skidding.

Extra width on curves is necessary not only to provide for proper sight distance but more especially to allow for the additional space taken up by a long vehicle in going around a sharp curve, due to the front and rear wheels not tracking. The amount of the extra width may be determined by the formula:

$$W = 2\,(R - \sqrt{R^2 - L^2}) + 35/\sqrt{R}$$

in which W is the additional width, L the wheelbase of the vehicle, and R the radius of the curve. It has been suggested that L be taken as 20 ft. While this value is satisfactory for a single vehicle, it is not sufficient when there are two or more vehicles hitched together. The use of trailers, one or more, is becoming common on all of the highways. The total length of vehicle and trailers may be as great as 60 ft. in some of the states. With these conditions it will be necessary to widen pavements on curves a greater amount than has been customary heretofore.

More attention will necessarily have to be given to the use of the highways by pedestrians, and facilities provided so that they will not have to use the pavement proper. An examination of the traffic data given above shows that nearly 22 per cent of the pedestrians killed were walking on the roadway. Here is one feature of highway design about which there should be no argument. The use of the highway by pedestrians is obviously unsafe. Yet they cannot be denied such use. For the heavily traveled roads near cities this means that paved sidewalks must be provided for pedestrians. Outside the urban sections the cross-section of the highway should be widened sufficiently to provide a walkway that can be used by pedestrians with safety.

Highway bridges need to be widened. Even when the location of a bridge and its approaches has been made satisfactorily, the bridge may constitute a traffic hazard due to its narrowness. Highway-bridge engineers should remember that there is a feeling on the part of the driver of a motor vehicle that a bridge is actually narrower than it really is; and there is a resulting tendency to steer farther away from the girders or guard-rail. This reduces the effective width of the pavement on the bridge. Bridges, of course, should never be narrower than the pavement; they should preferably be at least 3 ft. wider on each side. Not only is this sound from the standpoint of the safe use of the road but it will make it possible to widen the pavement for future highway development without having to tear down the bridge.

Maintenance

Maintenance affects the safe use of highways, particularly in the type and placing of warning signs, repairs and detours, and the type and maintenance of shoulders. Standardization of warning signs has been undertaken during recent years, and much improvement has been noted. The proper placing of these signs is quite difficult. As a general rule, the attention of the motorist should not be called to a feature that does not actually constitute a hazard, otherwise there will be a tendency to disregard all warning signs. Where hazards actually exist, the warning signs should be placed at a sufficient distance from them so that there will be ample opportunity for stopping a vehicle going at the maximum speed in common use. For 60 miles per hour this would require at least 250 ft.

The shoulders of hard-surfaced pavements need especial attention in periods of wet weather. They can quickly become the most dangerous elements in the cross-section of the road. The rut that forms at the edge of the pavement is responsible for a significant number of fatal motor-vehicle accidents. For example, in North Carolina the traffic data show that at least 7 per cent of the fatal traffic accidents were due to driving off the pavement or roadway. The National Safety Council estimates that this cause was responsible for at least 15 per cent of the motor-vehicle accidents in the United States in 1929. It is clear, therefore, that highway engineers need to give special attention to the conditions of the shoulders of the highways if this type of accident is to be reduced to a minimum.

Conclusion

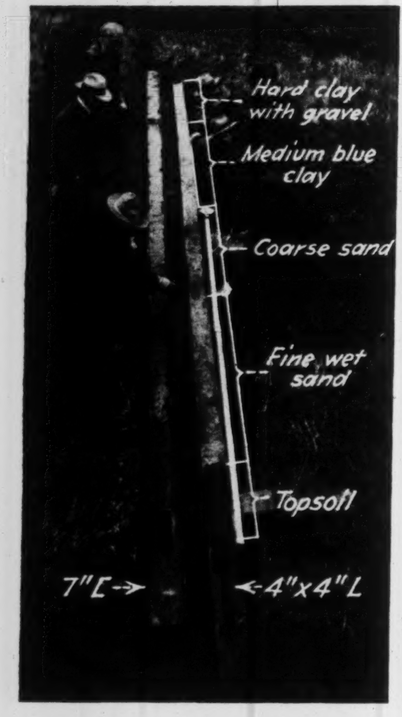
Safety in the operation of motor vehicles should be a fundamental consideration in the location, design and maintenance of a highway. While the cost of the road project may be increased, it should be remembered that small expenditures for the elimination of traffic hazards are always justifiable. For the main heavily traveled routes no reasonable expenditures should be spared in the construction of the road so that its use can be safer. But, since highway funds are generally limited, it will not always be possible to build every road free from elements of danger in the operation of motor vehicles or its use by pedestrians. The highway engineer should, therefore, in such cases as these:

1. Make a thorough study of each location and design of a highway from the consideration of *its safe use*. Such a study will often reveal that changes can be made that will decrease or eliminate the traffic hazards without increasing the cost of the project.
2. Safeguard the remaining hazards with warning signs and devices and proper maintenance so that the element of danger will be greatly reduced.

The safe use of highways will always, to a considerable extent, depend upon the drivers of the vehicles. But this responsibility does not relieve highway engineers of the duty of building roads that will not have those inherent defects in their location and design that so often are contributing causes of motor-vehicle accidents.

Long Earth Cores Obtained by New Driven-Casing Method

THE difficult task of obtaining intact earth cores 30 or 40 ft. long has been successfully performed by a newly developed method of subsoil exploration at the West Side sewage-treatment plant of the Sanitary District of Chicago. The method consists of driving successively to the desired depth two structural-steel shapes, a 4x4-in. angle and a 7-in. channel, and then withdrawing them simultaneously to inclose a triangular core of earth. When the channel is removed from the angle, after being drawn from the ground, a complete vertical section of the subsoil is in evidence.



The various layers of subsoil through which the steel has been driven are completely revealed by the core removed.

The new exploration method was developed by A. J. Forschner and R. H. Burke, of the T. J. Forschner Construction Co. (which has patented the method) to yield information as to subsoil conditions more accurate and reliable than that obtained from test pits. Its first practical application was to the explorations made at the sewage plant in preparation for the construction of a battery of aeration tanks being built under direction of L. B. Barker, principal construction engineer of the District. Tough clay is found at a depth of 20 to 40 ft. over most of the area, but above it there is a complicated subsoil consisting of sand, silt, clay and peat.

An air-driven pile hammer is used to drive the steel shapes into the ground. The angle is driven first. Its length is such that after it has penetrated the tough clay for 1 ft. or so there are still several feet above ground. A 7-in. channel is then driven down alongside it in such a position that the inside of the web spans across the angle's outstanding legs, forming a triangular core space. For the lower 18 in. the channel's flanges are crimped in so as to grip the angle legs loosely, forming an interlock and guiding the channel during driving. Channel and angle are driven to the same depth.

For pulling the casing after driving, a heavy latch bar is inserted in a slot near the top, extending through both angle and channel. This bar is lashed to a six-sheave block reeved to a similar block at the top of the leads and thence to the drum of the crane. In this way a pulling power of 75 tons is obtained, with the thrust transferred to the ground through the leads, which have a spread base for bearing. After the casing members have been withdrawn, a lever jack is used to slide the channel along the angle until the crimped section is clear, when it can be lifted off. A complete triangular core of the subsoil to the depth penetrated is then available, showing plainly the thickness and depth of the various strata. Information is available as to the moisture content at various depths, and the engineer is enabled to judge the relative hardness and bearing value of the material encountered.

At points where the hard clay is thought to be more than 30 ft. below ground, 40-ft. lengths of steel are used. Otherwise, 30-ft. sections are sufficiently long. Under no condition is there any slippage at the lower end of the core. After withdrawal of the steel the top of the core corresponds in position with a chalk mark made on the outside of the angle at the ground surface.

Load and Pull Tests on Steel H-Section Piles

By Jack Singleton

District Engineer, American Institute of Steel Construction, Topeka, Kan.

RECENT INCREASE in the use of steel H-section piles for bridge substructures recalls two tests made several years ago in Nebraska. In 1927 the department of public works performed load tests on two 8-in. 32-lb. H-section piles in the foundations of the bridge at Gothenberg. Maximum loads of 165.5 and 173.2 tons were applied to each of the piles, respectively, with no penetration resulting. Strain gages attached to the flanges and the web of each pile, together with accurate total loads applied by means of hydraulic jacks, enabled the data in Fig. 1 to be plotted. As indicated, the stresses exceeded the elastic limit of the steel, and this fact also was borne out by the cracking off of mill scale and the bending of the piles during the load application.

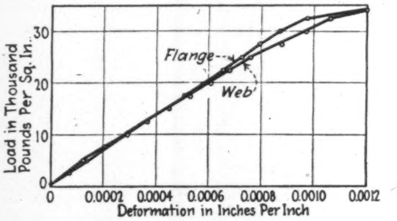


Fig. 1—Stress-strain diagram for an 8-in. 32-lb. steel H-pile.

During the same year it was necessary to pull steel piles that had been in place fourteen years supporting a 200-ft. span of the Mackinaw bridge near Arlington, Nebraska. The piles were 8-in. 39.5-lb. H-sections driven about 31 ft. into a sand and clay formation. A load of 220,000 lb. was required to pull the pile upon which the test was made. The results of this pull test are shown in Fig. 2. It should also be noted that a piece 3 ft. long cut from the bottom of one of the pulled piles weighed 40.2 lb. per foot. The original shop coat of red-lead paint was unimpaired. Another section 6 ft. long weighed 40 lb. per linear foot and showed but slight evidence of corrosion.

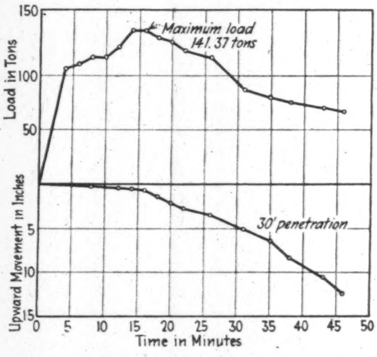


Fig. 2—Pulling-test curve for 8-in. 32-lb. H-piles.

Progress on New Mexico Control of Underground Water Supplies

Legal flaw is corrected in law making underground waters subject to appropriation—State funds available for plugging leaking wells in Roswell artesian basin

THROUGH the correction of a legal flaw in its original act, making underground waters subject to appropriation, and the providing of $20,000 for plugging leaking wells in the Roswell artesian basin, the state of New Mexico is making definite progress in the control of its groundwater supplies. The legal measure is of particular importance in controlling the situation in the Roswell basin on the eastern side of the state, where continued artesian flow and pumping have seriously affected the supply. The law makes such water subject to appropriation and places the administration in the hands of the state engineer. According to principles of water law in New Mexico, in common with other arid states, this makes beneficial use of the measure and limit of the right to use such water.

The original statute declaring all waters of underground streams and basins to be public waters and subject to appropriation was passed by the 1927 legislature, and administrative control was assumed by the state engineer on July 1, 1927. The act was quoted in *Engineering News-Record,* Sept. 8, 1927, p. 395, and was a direct result of studies made on the Roswell basin supply and the finding of a growing deficiency caused by waste. Test cases of this law developed the unconstitutionality of the act because of a legal flaw. The State Supreme Court held that the act extended *by reference only* the existing laws of the state, whereas the constitution required that every section thereof, as extended, must be set forth in full. The court did not question the principle of the legislation, and the 1931 legislature reenacted an act to overcome the legal difficulty.

In brief, the object of the law is to place "the waters of underground streams, channels, artesian basins, reservoirs or lakes, having reasonably ascertainable boundaries," under the jurisdiction of the state and declare them public waters. Such declaration makes them subject to appropriation and the rules of prior rights, beneficial use and other features of the appropriation doctrine. Rights to use are to be established in a manner paralleling the appropriation and use of surface waters. Application to the state engineer is required and permits for use are necessary.

At the same session of the legislature $20,000 was appropriated to be used "for the purpose of causing artesian wells in the Pecos Valley artesian basin [Roswell basin area] found by the state engineer to be leaking and wasting the water from said reservoirs to be plugged or repaired so as to preserve the permanency of the reservoir or reservoirs and to prevent further waste therefrom." This program was a direct result of the study that found many of the older wells in the artesian basin badly in need of repair, rusting of the casing in many cases permitting the artesian supply to leak into the upper strata. The work is being done under the supervision of the state engineer, and it is planned for the appropriation to be sufficient to work out a method for plugging the wells in an efficient and economic manner so that owners will be able to carry on this work on the basis of the findings made. At present the work is in a preliminary stage and various methods are being tried. Methods of plugging with cement, common to the use in oil fields, are not economically feasible for the present purpose. Therefore, a study is being made along the lines of mud plugging, using a concrete cap to maintain the plugs. This program is most essential in maintaining the supply in the Roswell artesian basin and must be carried forward if the permanency of this water supply is to be assured.

The administration of the new underground-water law and the well-plugging operations are under the supervision of George M. Neel, state engineer.

Vast Mileage of Pipe Lines Laid in 1931

PIPE-LINE WORK formed one of the bright spots in 1931 construction, more than 15,000 miles of trunk pipelines for gas, oil and gasoline being laid, which with the feeder lines accounted for expenditures in excess of $400,000,000. This mileage represented 7,700 miles of gas, 4,200 miles of oil and 3,400 miles of gasoline lines according to a report in the January issue of *Pipe Line News.*

Seventy-five per cent of the total expenditure was for gas pipe-lines. Leading projects included the 467-mile, 20-in. line of the Columbia Gas & Electric Corp., from Maytown, Ky., to Coatesville, Pa.; the 110-mile, 20-in. line of the Lycoming Natural Gas Corp., from the Tioga field in New York to Syracuse; the 200-mile, 20- to 12-in. line of the Montana Power Co., supplying Butte and Anaconda; the 1,000-mile, 24-in. line, from the Texas Panhandle to Chicago, of the Natural Gas Pipeline Company of America, completed during the year at an expenditure of $50,000,000 (compared with half that amount in 1930); the 1,855-mile, 26- to 14-in. line of the Northern Natural Gas Co., from Skellytown, Tex., north to Minnesota and North Dakota, upon which $45,000,000 was spent; the 1,400-mile, 24- to 4-in. line from the Texas Panhandle to the Illinois-Indiana line, of the Panhandle Eastern Pipe Line Co.; additional work on the 200-mile, 26-in. line from Kettleman Hills southward in California, owned by the Southern Fuel Co.; and the 900-mile, 14- to 2-in. line of the United Gas Corp., in Texas and Louisiana, upon which $20,000,000 was expended. One of the most interesting operations was that of reconditioning as a natural-gas main the old Sinclair oil line from Teapot Dome in Wyoming to Kansas City; cleaning machines were blown through the line at speeds up to 50 m.p.h.

Oil pipe-lines recorded normal extension, the Gulf Pipe Line Co. continuing work on its 730-mile line from Oklahoma to Ohio, the Shell Pipe Line Co. on its 200-mile Kilgore-Houston line in Texas, the Standard Pipe Line Co. on its 195-mile line from Oklahoma to Whiting, Ind., the Texas-Empire Pipe Line Co. on its 205-mile line from the East Texas field to Port Arthur (incidentally built complete in less than two months) and the Sun Pipe Line Co. on its 200-mile line from Longview to Beaumont in Texas.

Gasoline-line construction presented a most interesting development. Gasoline lines, unlike oil and gas lines, do not have a definite terminus. Rather they comprise distributing systems touching as many consuming centers as possible. The largest project of the year was the 1,400-mile, 4-, 6- and 8-in. line of the Great Lakes Pipe Line Co., from Ponca City, Okla., through Kansas City and Omaha to St. Paul, a total of $15,000,000 being expended on this line in 1931, compared with one-third that amount in 1930. Two other large gasoline pipe-line operations were those of the Phillips Pipe Line Co., from the Texas Panhandle to St. Louis (680 miles) and of the Sun Pipe Line Co., from Marcus Hook, Pa., west to Cleveland and north toward Syracuse (730 miles).

New Lightweight Car Built for Fast Railway Service

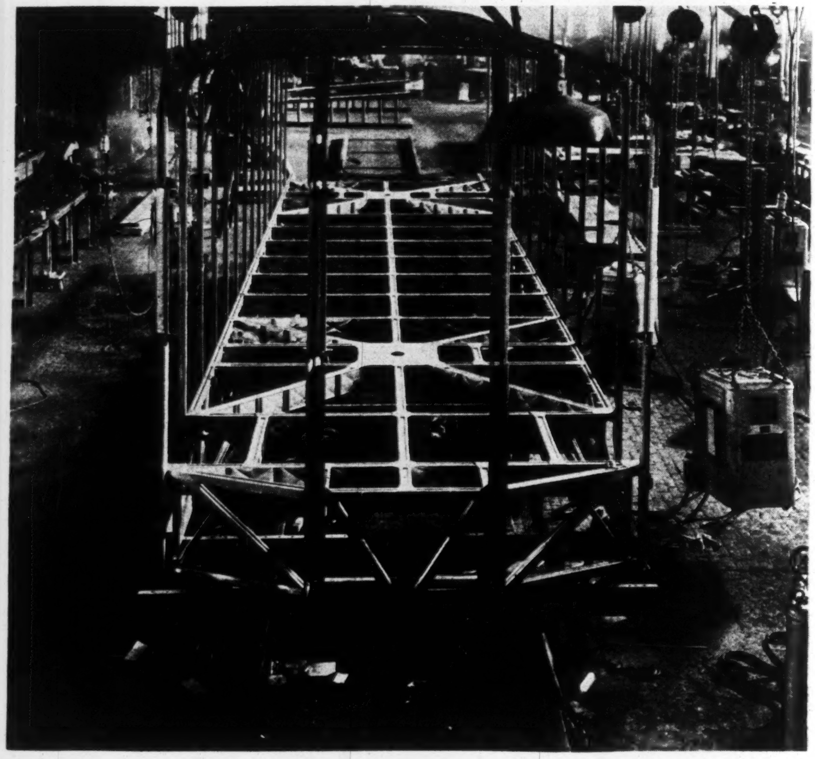
Thin sections of stainless steel used in the frame and for the car body—Car supported on six-wheel truck with pneumatic tires of new design

RADICAL DEPARTURES from accepted practices are found in a new rail car recently built at the plant of the Edward G. Budd Manufacturing Co., in Philadelphia, and put through a test run on the Norristown branch of the Reading Railway on Feb. 19. The car is much lighter in weight than any car of the same carrying capacity yet built, is self-propelled and has pneumatic tires similar in design to those recently developed in France by M. Michelin. This new car, however, is an improvement over the pneumatic-tired cars built in France in that the body of the French cars were built along conventional lines, while this new car, built under Budd patents, has an entirely new body design fabricated in large part of thin-section stainless steel. Every part of the car, including the wheels, truck frames and seats, has been designed for maximum strength with minimum weight.

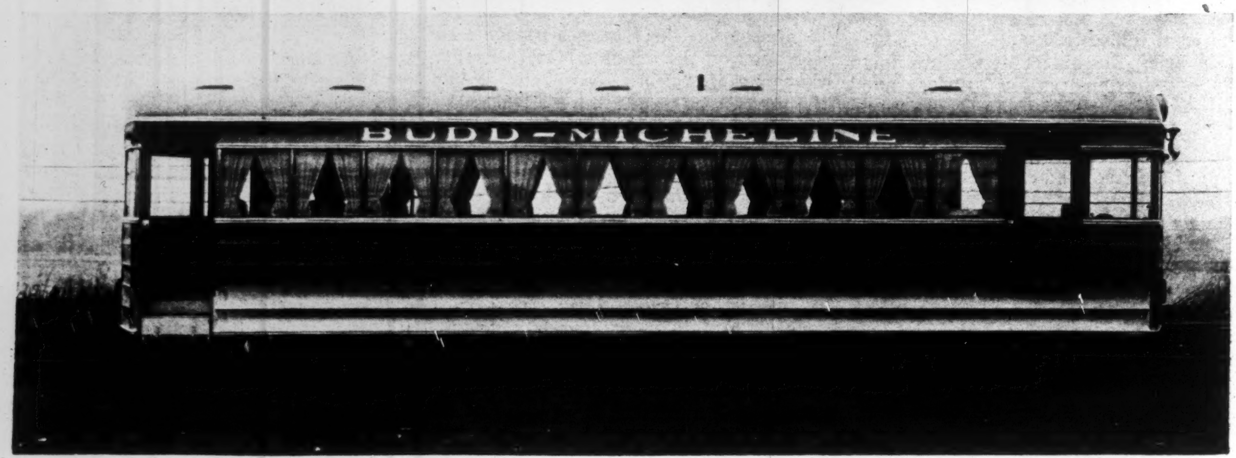
The new car has a length of 41 ft. 8 in., a width of 8 ft. 9¾ in. and a height above rail of 10 ft. 6 in. It is designed to carry 40 passengers and 1,500 lb. of hand baggage. The body weighs, 6,341 lb., the motive power plant 1,600 lb., the driving truck 2,879 lb. idler truck 1,931 lb., and the miscellaneous parts weigh 797 lb.—a total of 13,548 lb. This gives a weight of 340 lb. per passenger, as compared with 1,000 lb. in a standard railway coach and 5,000 lb. for Pullman sleepers. Similar self-contained rail cars weigh from 130,000 to 240,000 lb.

Motive power of about 90 hp. is used to propel the new car, as against from 300 to 900 hp. for old-style rail cars.

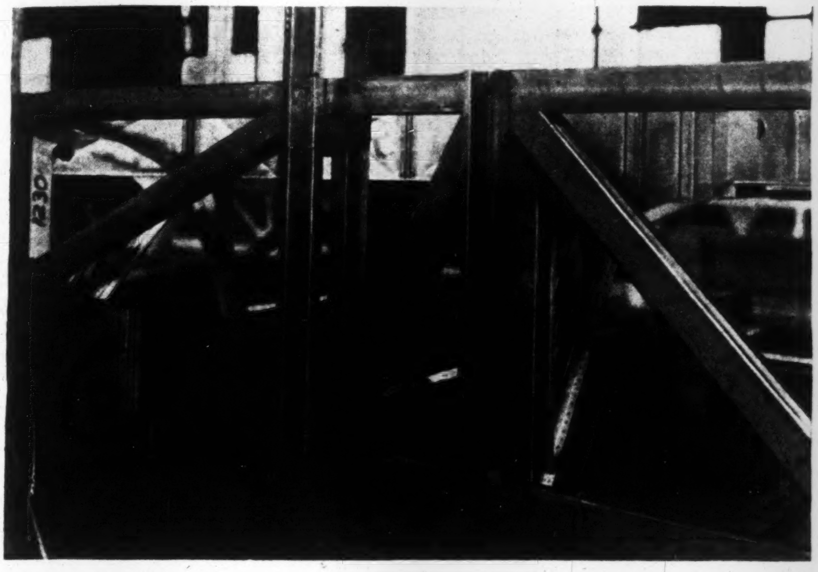
The framework of the car is notable. It is built up almost entirely of specially formed structural shapes of stainless steel in thickness ranging fro 0.01 to 0.04 in. and having a tensi strength of 150,000 lb. Details ar shown in the accompanying illustrations. Because of the extreme thinne of this metal ordinary fabricatin methods were found unsatisfactor Rivets would not give sufficien strength and welding, as usually practiced, would alter the chemical composition of the metal, exposing th welds to corrosion. Solution of th problems was found in the developmen in the Budd plant of a new method o welding termed "shot-welding," i which the parts to be joined are spot



Thin sections of light-weight stainless steel are used to give the body strength equal to that of standard designs, but at a great saving in weight.



An entirely new approach to rail-car design was made in working out the details of the Budd-Micheline car.



The use of thin stainless steel calls for new structural shapes and a special form of electric welding.

welded by an electric weld so nearly instantaneous as to have no effect upon the chemical composition of the materials joined.

Concave strips are used for the sides of the car to avoid the distortions that develop in thin plates when used flat for such purposes.

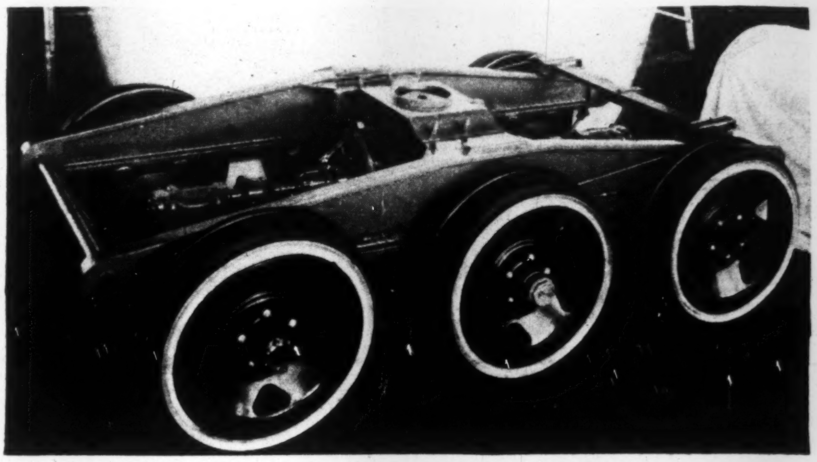
Weight is saved in the body by the use of fixed windows and by reducing seat weights from 85 to 35 lb. per unit. Ventilation is provided through a small air-conditioning plant, which distributes fresh cooled or heated air throughout the car. The walls are insulated, and a thick cork flooring is used over the floor plates.

Each truck carries the brake equipment and six flanged steel wheels with patented demountable pneumatic tires inflated at 85-lb. pressures. The air chamber is of dumbbell shape, the opposing lugs forming the narrow central portion of the air chamber acting as supporting shoulders upon which the weight is carried in case the inner tube is deflated. This arrangement prevents the complete collapse of the tire while running, with the possible chance of having the wheel flange shear off the rail-joint bolts. The car can be operated safely with one or all tires deflated. A tire life of 20,000 miles is expected.

There are automobile-type air brakes on eight wheels and hand-actuated emergency brakes on four wheels. A full stop from a speed of 60 m.p.h. can be made in 400 ft. The car is equipped with standard railway signals, including an automatic signal shoe. All windows have non-shatterable glass.

The car is designed especially for branch-line service. Because of its lightness and the better adhesion of its rubber tires it can accelerate at a higher rate than is possible with present equipment. It is designed to operate at speeds up to 60 m.p.h. Operating costs are estimated at from 15c. to 25c. per mile, as against 75c. to $1.25 at present. The car is now powered with an ordinary automobile engine, but the design provides for the use of a diesel engine or electric power.

Six-wheel trucks serve to distribute the load on the pneumatic tires.



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A Library of Land and Water Transportation

University of Michigan makes progress in collection of historical data on all forms of transportation

IN DISPOSING of the library of a late railway engineer a few years ago a number of volumes of evident value were retained, but a great mass of material was sold as waste paper. Too late it was discovered that the material thus lost included books, pamphlets, reports and documents of great value in relation to the history of railway transportation and railway engineering, which evidently had been collected with much care and trouble. This is only one of many such cases of irreplaceable loss. Knowledge of this situation was among the reasons for the establishment of the Transportation Library at the University of Michigan, with the aim of developing a special permanent collection under competent and sympathetic management, as well as to provide a place for individual collections.

Much literature collected

The organization of this library began in 1922, when John S. Worley, consulting engineer, became professor of transportation and railroad engineering at the university. Realizing from his own experience the lack of any complete collection of the literature on transportation, he undertook not only to develop such a collection but also to make it available as a library for general reference and research. This purpose has been pursued actively, with highly valuable and interesting results, aided by the cooperation of owners of individual material or private collections. At present there are about 100,000 books, pamphlets, technical reports, annual reports of companies, prints, engravings and a variety of historical documents and modern records. There are also a few models of ships and railway track devices. A card inventory covers the entire collection, but is not yet cataloged according to standard library practice.

While this transportation library is a part of the university's general library system, it is housed separately in the Engineering Building, a modern fireproof structure. It has also a separate administrative board, consisting of Dr. W. W. Bishop, librarian of the university, Prof. Henry E. Riggs and Prof. J. S. Worley, the last being curator of the Transportation Library.

To illustrate the value and interest of the present collection the following items may be noted: Fulton's treatise on canal navigation, 1796; Strickland's report on canals, railways and roads, 1826; volumes of ancient engraved road maps of England (a strip of road on each page, with branches, crossroads, castle, topographic features, etc.); engravings of automotive vehicles of 1516; Nicholas Bergier's general history of highways, 1712; John Ogilby's "Britannia, or the Kingdom of England and Dominion of Wales actually surveyed," with 107 maps, 1698; original copies of patent papers of John Stevens' steam engine; the *American Railway Journal* 1832-1860; lithographs of early noted American steamers on inland waterways, and a fairly complete file of books and pamphlets on the Liverpool & Manchester Railway, 1831. More modern material includes correspondence and instructions of the late C. A. Prouty, director of federal valuation, and the correspondence of the Am. Soc.C.E. committee on valuation (this latter being the file of the late F. P. Stearns, chairman of the committee).

This special library is intended to cover the entire field of transportation, and its fundamental purposes have been outlined as follows: (1) to develop a complete collection of modern technical literature pertaining to various transportation agencies; (2) to collect and preserve historical matter; (3) to prepare a bibliography of transportation literature; and (4) to furnish a cultural background for those engaged in or interested in transportation. To further these purposes, donations of old or modern publications, records and historical matter are invited, not only to enlarge the collection but also to preserve material that migh otherwise be lost or dispersed owing to the death of the owner or other conditions. The library may also be made the repository for private collections which will thus become generally available for use in study and research.

Other libraries

A few other universities have large collections of books and other documents relating to transportation. The largest collection of railroad material in the country is believed to be that at Leland Stanford University in California. Columbia University has a good nucleus of such a library, and Harvard, while having no special transportation collection, includes the subject in the Baker Library. The university also has a special library on traffic, established in 1926 as part of the Erskine Bureau for Street Traffic Research, and has the museum collection of the Railway and Locomotive Historical Society. The largest private collection in this country is that of Wm. Barclay Parsons.

* * *

Labor Gets 85 Per Cent of Highway Money

A STUDY to determine the extent to which expenditures for highway improvement provide employment has just been completed by the Bureau of Public Roads. Concrete pavement was selected for this study because the effect of expenditures for pavements of this type in providing employment is believed to be typical for paving and for public works generally.

Expenditures were traced through the various industries affected, and the amounts paid as wages and salaries were set aside for accumulation. In the end, labor was found to receive the larger part of these expenditures, which is an altogether reasonable conclusion, since the materials entering into highway construction are of little value in their original state. Practically all of the value that the finished pavement possesses is created by the application of labor directly and through manufacturing processes and transportation.

An extended analysis of the cost of laying concrete pavement in three typical states during the calendar year 1929 produced the distribution of cost shown by Table I.

To ascertain the amount of labor involved in each of these items, except the first, which already is a labor item, the study included the intensive analysis of their component parts. The details of these analyses are not repeated here, but the results appear in Table II. The largest single item in Table II is freight, $406.70, which is about 40 per cent of the cost of concrete-pavement construction. This item distributed is shown by Table III. Table IV is a similar analysis for fuel.

From these tables it is clear that although job labor receives only a little more than 15 per cent of the sum expended on the construction of a concrete pavement, the labor involved in producing the materials, in transportation and in obtaining the necessary fuel, is so large that the distribution to salaries and wages is well over half its total cost.

The preceding quantitative discussion is based on a period of unusual business activity. In times of depression such as the present the residue, composed of interest rents, royalties and profits, shrinks both in absolute amount and in relation to the total. In view of this well-known fact it seems probable that, of the total expenditure for road construction at the present time, nearer 85 than 75 per cent may be thus directly traced into the hands of labor.

TABLE I — ANALYSIS OF COST OF CONCRETE PAVEMENTS IN THREE TYPICAL STATES

	Cents Per Sq.Yd.	Dollars Per $1,000 of Expenditure
Labor	26	141
Aggregate	60	324
Cement	60	324
Steel	05	27
Equipment	18½	100
Getting onto job and installation of plant	05	27
Bonds and insurance	04	22
Job margin	06½	35

TABLE II — SUMMARY OF THE VARIOUS STEPS THROUGH WHICH THE CONTRACTOR'S PAYMENT OF $1,000 IS TRACED AND THE AMOUNTS ATTRIBUTABLE TO EACH

Item	Salaries and Wages	Freight	Material and Supplies	Fuel	Interest	Taxes	Depreciation and Repairs	Depletion	Profit	
Salaries and wages	$141.00	......	......	......	......	......	......	......	......	......
Aggregate	50.00	$194.00	$18.00	$11.00	$4.00	$6.00	$29.50	$7.50	$4.00	......
Cement	61.00	113.50	30.00	22.50	4.50	5.00	53.50	3.00	31.00	......
Steel	6.00	6.20	8.50	1.50	0.40	0.90	2.50	......	1.00	......
Equipment	5.20	4.50	10.65	0.50	0.20	7.20	70.65	......	1.10	......
Getting onto job	13.50	13.50	......	......	......	......	......	......	......	......
Bonds and insurance	11.00	......	......	......	......	......	......	......	1.00	$10.00*
Job margin	15.00	......	......	......	5.00	5.00	......	......	10.00	......
	$302.70	$331.70	$67.15	$35.50	$14.10	$24.10	$156.15	$10.50	$48.10	$10.00
†Adjustments	......	+75.00	—50.00	......	......	......	—25.00	......	......	......
	$302.70	$406.70	$17.15	$35.50	$14.10	$24.10	$131.15	$10.50	$48.10	$10.00

*Set aside for later redistribution.

†These adjustments are made here to avoid recasting the freight analysis on account of the freight charges that are a part of the cost of repairs, replacements, materials and supplies.

TABLE III—DISTRIBUTION OF FREIGHT COSTS FOR CONCRETE PAVEMENT

Salaries and wages	$477.70
Materials and supplies	57.55
Fuel	57.20
Interest	61.70
Taxes	49.70
Depreciation and repairs	184.65
Profit	91.00
Depletion	10.50
Redistribution	10.00
	$1,000.00

TABLE IV — DISTRIBUTION OF FUEL COSTS FOR FREIGHT

Salaries and wages	$516.00
Materials and supplies	64.20
Interest and rents	63.75
Taxes	51.40
Repairs and depreciation	188.75
Profit	91.00
Depletion	14.90
Redistribution	10.00
	$1,000.00

From Job and Office

Dredge for Reservoir Cleaning
Records of Slope Stakes
Job and Office Notes
Building Design Simplified
Load Tests for Hardpan
Chart for Beam Design

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Improved Method of Slope Staking

By A. H. Bell
Engineer of Surveys, Virginia Department of Highways, Richmond Va.

A CHANGE made by the survey division of the Virginia department of highways in the method of recording slope-stake and final cross-section notes has resulted in increased accuracy in final earthwork estimates and in an ultimate saving in the time required to complete them.

The usual method of setting slope stakes is employed, using the balanced templet line as a basis in all cases, this being an average line across the cross-section to which the rough grading is done. But instead of the usual three-point sections being recorded, complete and accurate cross-sections are taken showing all breaks in the ground. Slope stakes are set in line, but 5 ft. outside of their true position, and 5 ft. beyond each slope stake is set an additional liner stake with elevation recorded.

Rod readings are recorded for all intermediate points as well as for center and slope stake points, and are reduced to elevations. The H.I. for each section is obtained by adding the rod reading on the ground at center line stake to the ground elevation at that point as previously determined by an accurate line of levels.

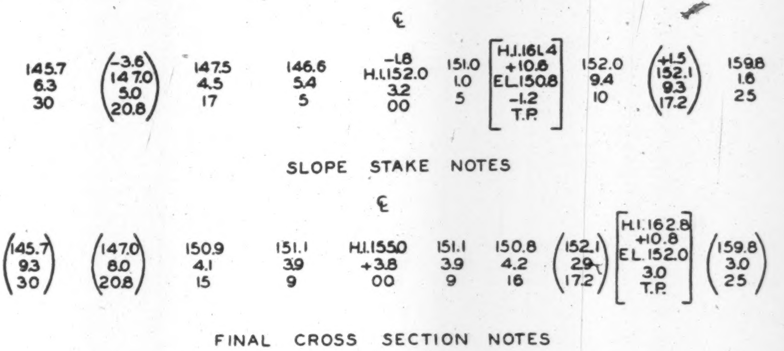
Cross-sections are also taken in the same manner at all appreciable breaks in the profile and at abrupt changes in the contour of the cross-sections.

By this method a complete set of original cross-sections is obtained on the exact center line of construction and based on actual elevations from an established datum.

As soon as the slope-stake work is completed the notes are sent to the main office, where they are plotted and laid away until the construction work is completed and the final survey made. This distributes a part of the final office work over the entire year, relieving the congestion at the end of the construction season.

The final cross-sections are recorded in a form similar to that used for slope-stake cross-sections. The H.I. for each section is obtained by adding the rod reading on the finished center line grade to the elevation of the grade at that point as established by the final levels. Rod readings are then recorded for the edges of the pavement, ditch lines and at other breaks in the section, also at slope stake points and at liner stakes. Elevations are computed for all points where readings are taken. We then have final cross-sections based on actual elevations from the same datum from which the original sections were taken and accurately tied into them.

By this method of staking out and taking final cross-sections, the error of closure due to inaccuracies in the work and the variation in direction of the two sets of sections is materially reduced. Although somewhat more time and care in the field work are required, it is fully justified by the saving in office work, added confidence in the reliability of the final estimates and the possession of a complete record of all field work.

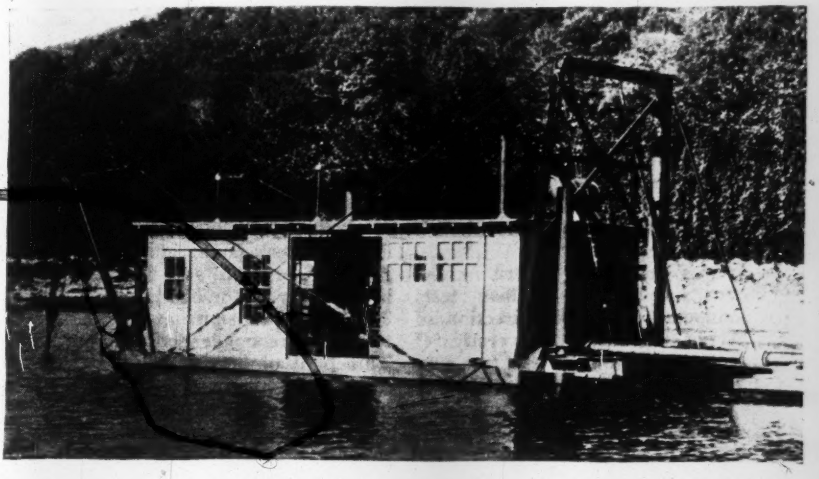


Typical record of slope stake and final cross-section notes.

Knock-Down Suction Dredge Cleans Reservoir

WHAT IS SAID to be the smallest suction dredge ever built with cutter machinery has been acquired by the Newark, N. J., department of public works, division of water, for removing silt deposits from reservoirs in the city's water-supply system. The first task of this machine has been the cleaning of Macopin intake, a 32-m.g. reservoir with a surface area of 12 acres used as collecting and settling basin on the Pequannock watershed. Deposits in this basin, varying from a thin film to a 4-ft. depth, have been causing turbidity of the water and sedimentation in the pipes. As the material is too inert to be removed by straight suction methods, the use of a suction and cutter dredge, supplemented by hydraulic equipment, was decided upon. Ease of dismantling was a factor in choosing equipment in order that subsequent transfer to other reservoirs might be facilitated.

The hull of the dredge is made in two pontoon sections, to be bolted together in the water, and is light enough to be trucked to any land-locked water supply



Small suction dredge with cutter equipment.

and strong enough to withstand frequent launching. Each section is 31 ft. long with a 14-ft. beam and 2-ft. draft and is trussed internally. Electrically welded steel is the material used. Joining these two sections gives a hull 31x7x3 ft. in size, upon which is mounted a full 6-in. suction of standard design. Manganese steel is used for the outer and inner casings of the dredge pump, and also for all working parts, because it was recognized that the dredge would necessarily pick up a number of fairly large boulders. The pump is directly connected to a 112-hp. six-cylinder gasoline motor and is designed and tested for 1,250 g.p.m. against a 125-ft. total head.

Hydraulic equipment consists of a gasoline-engine-driven pump delivering 1,000 g.p.m. to three $1\frac{1}{4}$-in. nozzles at 92-lb. pressure. This is driven by a six-cylinder 90-hp. gasoline motor. Equipment also includes 2,500 ft. of piping with necessary fittings.

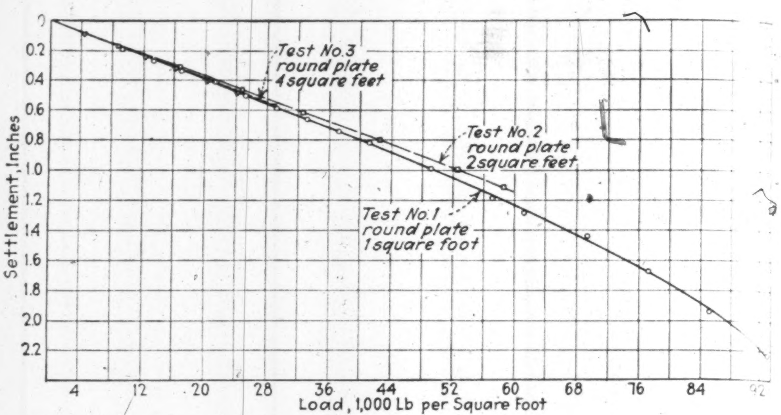
Other equipment includes a general-service centrifugal pumping unit with a capacity of 60 g.p.m. against a total head of 75 ft., driven by a 3-hp. air-cooled motor, and a five-drum winch powered by a four-cylinder gasoline motor. A similar motor drives the cutter equipment. The A-frame, spud frame and gallows frame of the dredge are of steel, and the wooden deckhouse is of sectional construction that can be disassembled readily. The discharge piping is 8 in. in inside diameter throughout and consists of fifteen 30-ft. pontoons, two pontoon elbows, two 10-ft. pontoons and 1,320 lin.ft. of 8-in. piping.

◆

Load Tests on Hardpan

SOIL-BEARING tests were required for a building at Lansing, Mich., when a change was made in the foundation design. The structure in question was the City National Bank Building, a fifteen-story steel-frame structure 88x67 ft. Pile foundations were planned originally, but adjacent buildings were found to be in such condition as to make piledriving hazardous on account of vibration and soil disturbance. A change was made therefore to a series of concrete piers, built in open wells sunk through 15 ft. of water-bearing sand and 4 or 5 ft. of hard gumbo clay to a hardpan stratum. This hardpan consisted of a very stiff blue clay compressed almost to the character of a soft stone and heavily impregnated with sand and pebbles.

As it was desired to determine the bearing capacity of the hardpan, tests were conducted under the direction of Prof. W. S. Housel, University of Michigan. Apparatus for the test consisted of a 12x12-in. post placed upon a steel plate on the hardpan and carrying a 60-ton hydraulic jack, upon the head of which rested the bottom beam of a wooden bin which was held in position by vertical guides.



Load-settlement diagrams for tests on hardpan using three sizes of bearing plates.

Loading was increased in 2-ton increments at fifteen-minute intervals up to a total load of 92,000 lb. per sq.ft., deflection readings being taken before and after each increase. Circular bearing plates were used under the compression post, with areas of 1, 2 and 4 sq.ft. for the three tests, respectively. Settlement was measured by a lever arm device which multiplied actual settlements by five and supplied an accuracy of 0.01 in. The circular areas were tested under conditions of total confinement due to overburden, the plates being set at the bottom of 3-ft. holes having the same diameters as the plates.

The slope of the load-settlement diagram was practically the same for the three test areas. This indicates, according to Prof. Housel, that bearing capacity is dependent only on the developed pressure and that the perimeter effect is negligible. "The phenomenon of variation in bearing capacity with size of bearing area is dependent on the relative amount of boundary shear as compared to direct pressure acting over the contact area. If the amount of boundary shear is negligible, the load-settlement diagrams for various sized areas should very nearly coincide. Such are the results of tests on the bearing areas of 1, 2 and 4 sq.ft., as shown in the diagram. This coincidence of the relation between load and settlement for various areas means that footings may be designed for equal pressures and negligible differential settlement."

With the circular plate 1 sq.ft. in area, the deflection, or compression of the soil, increased steadily from 0.5 in. at about 26,000 lb. to 2.2 in. at 92,000 lb., the maximum loading. Taking 70,000-lb. pressure as a basis and allowing a safety factor of $2\frac{1}{2}$, a load limit of 26,000 lb. per sq.ft. at 0.5 in. deflection was recommended for the piers. This limit of bearing capacity was selected as setting a maximum allowable change in slope of the load-settlement diagram, based upon the results of a number of other tests in which the bearing capacity limit had been measured. In actual design, however, this load limit was reduced to 20,000 lb.

For this bank building the architects are Lee Black and Kenneth C. Black, Lansing, Mich., with York & Sawyer, New York, as consulting architects. The Reniger Construction Co. has the general contract, and A. M. Woods is its superintendent. The building is to be completed this month.

◆

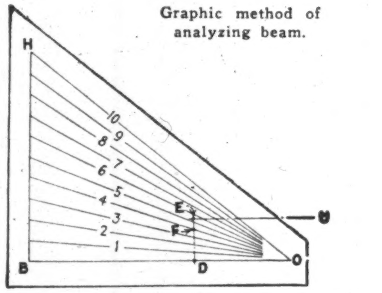
Influence-Line Chart for Beam Design

By Dana Young

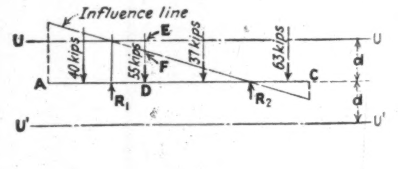
Structural Designer, United Engineers and Contractors, Philadelphia, Pa.

AN INTERESTING CHART for determining reactions, shears and moments in simple beams was described by the late Ernest McCullough in *ENR*, May 14, 1931, p. 818. The writer has used a somewhat different type of chart, which is more general in its application.

The chart, shown in Fig. 1, may be drawn on tracing cloth or scratched on a piece of celluloid. The lines radiate from point O and cut off equal segments on line BH. Its use may best be illus-



Graphic method of analyzing beam.



trated by an example. Consider the overhanging beam *AC* shown in Fig. 2. It is desired to find the reaction R_1. The influence line for R_1 is drawn, using any convenient distance *d* for unity. A horizontal line *UU* is drawn parallel to *AC* at this distance. The reaction due to the load at *D* is found as follows: slide the chart over the beam with the base *BO* directly over *AC* and place the chart so that the point *E* cuts 55 (or 5.5) on the radiating lines. Then read the value 40 on the chart directly over point *F*. This is the magnitude of the reaction due to the load of 55 kips at point *D*. The letters *D*, *E* and *F* in Fig. 1 show the position of these points relative to the chart for the above case.

In a similar manner the value of the reaction for each load is found. The sum of these values gives the total reaction. A uniform load may be handled as a concentrated load at its center of gravity. Where the influence line is below the beam, as it is to the right of R_2 in the example, the chart is inverted and placed between the beam and line *U'U'*. Values found in such cases are negative.

For more accurate results it is advantageous to have two or three charts drawn to different scales, using whichever one best fits the load under consideration. It will be noted that such a chart can be used to determine any function or stress for which an influence line can be drawn. It applies to continuous beams and to trusses as well as to simple beams.

Sign Interpretation in Slope-Deflection Analysis

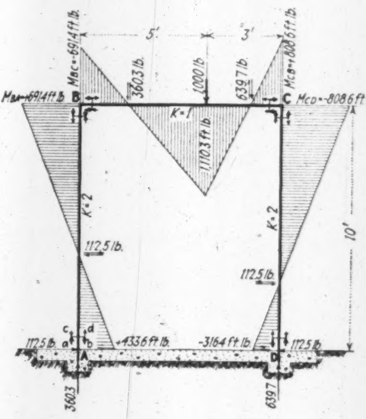
By J. E. Lothers

Associate Professor of Architecture, Oklahoma Agricultural and Mechanical College

THE slope-deflection method of getting the moments at the ends of the members of a rigid building bent for a given loading is comparatively simple and widely understood. Publications on the subject are clear and easily followed up to the point of obtaining the moments together with their signs. However, the interpretation of these signs, after they are obtained, is not so simple, and available publications on the subject dismiss this question with a short paragraph that is not clear to the beginner. In an endeavor to make the subject of slope deflections clear to his students, the writer has evolved some rules and methods of procedure for the interpretation of the signs. (For a general discussion of the slope-deflection method the reader is referred to Bulletins 80 and 108, Engineering Experiment Station, University of Illinois; or *Studies in Engineering Number 1*, Research Publications of the University of Minnesota.)

Fig. 1 is a sketch of a simple bent for which the moments, together with their signs, have been computed. These signs may be interpreted as follows:

To interpret the sign of an end moment, cut a section in the member near the joint at which the moment in question occurs. Next, consider the internal stress couple in the cut member on the joint side only of the section. For a positive moment this couple will tend to rotate in a clockwise direction. Hence, if the moment in question is positive, place the arrows on this internal stress couple so as to cause it to rotate the joint side of the member (and hence the joint itself) in a clockwise direction. Then the arrow that is pushing on the section and away from the joint will indicate compression in the fibers of the member on its side. The arrow that is pulling on the section and thus pointing toward the joint will indicate the tension side of the member and, therefore, the conventional side upon which to plot the moment. The above-mentioned couple is represented in Fig. 1 by means of heavy arrows. The resisting couple is next indicated on the opposite side of the section by means of light arrows, which, in conjunction with the heavy ones, show which side of the member is in tension (opposite pulling arrows) and which side is in compression (opposite pushing arrows).



Rigid building bent in which signs of bending moments are determined or visualized by plotting the internal (heavy arrows) and external or resisting (light arrows) stress couples at each joint.

Consider the *A* end of member *AB*, Fig. 1. $M_{AB} = +433.6$ ft.-lb. Since the sign of this moment in the algebraic process of solution came out positive, a clockwise couple is called for and, accordingly, the heavy arrows on the joint side of the section are made to indicate clockwise rotation (couple *ab*). The resisting couple, *cd*, is next placed on the opposite side of the section. It is now evident at a glance that the two opposite pulling arrows, *bd*, indicate tension in the fibers on their side of the neutral axis, and the opposite pushing arrows, *ac*, indicate compression in the fibers of the other side. All the other end-moment signs are similarly interpreted. In Fig. 1 the moments in every case have been plotted on the tension side of the members.

In practice the following shortcut may be used. It will be noted from Fig. 1 that, of the two heavy arrows constituting the first couple drawn at each section, the one pointing toward the joint is always on the tension side and indicates the conventional side on which to plot the moment. With a little practice a simple rotation of the pencil in the indicated direction of the heavy arrows will determine the tension side without sketching in either couple.

Job and Office Notes

USE OF A CABLE as a saw proved an expeditious method of wrecking an elevator in St. Louis, Mo. The elevator was built of 2x4-in. timbers laid on their sides and spiked together. The cable was fed from a point on the boom of a crane over the top of each bin wall, down the inside and out through a hole in the bottom to the drum of a shovel. Using the drums of the machines, the material was quickly cut into lengths that could be handled by the shovel and then loaded directly on trucks. Sam Kraus, of St. Louis, was the contractor.

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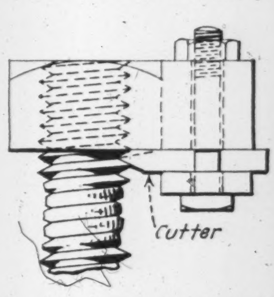
FOUNDATION BOLTS sometimes get bent during construction work, and, when straightened, the threads are so damaged that they will not take the nuts properly.



In such cases the device illustrated has been found useful in refinishing the thread. A lug welded to a standard nut is fitted with a two-hole clamp, which holds a hardened rethreading tool. If the latter does not line up perfectly with the thread, a thin shim may be required. By running this assembly down the bolt, it is a simple matter to restore the thread to usable condition.—**PAUL F. BERRY**, *Alabama Power Co., Birmingham, Ala.*

❖

DAMAGE TO highway-maintenance equipment by collisions with motor vehicles has become so frequent in Wyoming that Z. E. Sevison, state highway engineer, has ordered all equipment to be painted a "circus yellow" to increase its visibility. It is hoped that this plan will reduce the number of accidents.

Letters to the Editor

Incinerator Costs Require Analysis

Sir—Articles like the one appearing in your issue of Dec., 1931, p. 1046, entitled "Winston-Salem Combines Incineration of Garbage and Refuse" are always interesting. Incineration, like other forms of service in the municipal field, is a developing art, and if any municipality is so fortunate as to secure for itself an incinerator of outstanding efficiency, or if such incinerator has only average efficiency but is outstandingly economical in operating cost, then such municipality can be assured—as Emerson said of the man who could write a better book, preach a better sermon or make a better mouse-trap than his neighbor—the world will beat a pathway to its door.

But before the great trek starts for Winston-Salem it may be pertinent to call attention to certain statements and data appearing in the article already mentioned. This is done to clear up possible impressions that very likely were never intended to be conveyed.

The statement that the three incinerator units have a tested capacity for handling 500 tons of combined garbage and refuse in 24 hours is a claim that exceeds any performance records that have come to the attention of the writer for plants of this design, and likewise exceeds any guarantee of capacity heretofore made. If any such determination had been made in test, it would be highly interesting to know the conditions of the test and the character of the material that was disposed of.

While the total tonnage of waste is not stated, it may be ascertained by dividing the total cost by the cost per ton, which makes this 22,500 tons. By allowing 312 working days in the year the average daily delivery of garbage and refuse is found to be 72 tons, and further calculation shows the per-capita production to be 600 lb. This is information that it is always desirable to have definitely stated.

The plant investment of $286,000 represents $3.80 per capita. This unit cost is to be compared with like costs in various cities, and with an average for cities equipped for similar service, which I believe is about $1.50 per capita.

The operating costs for incineration are given as 65.444c. per ton, which appears low enough to compensate somewhat for the excessive per capita cost of plant and equipment noted above. However, a little calculation shows that the rate per day per man is about $3. The maintenance cost appears to be based on actual disbursements for this account, which, with the plant in its first year of operation are usually low and therefore not representative of the average over any extended period. But, dealing with the labor factor only and adjusting this to a rate corresponding to that obtaining in northern cities—say $5 per day—the cost for this item alone would be increased by $6,415, or 28.5c. per ton, making the total labor cost on this comparable basis 71.3c. per ton instead of 42.778c., which is not exceptional as operations go in well-equipped and efficiently operated plants.

It is stated that these costs carry nothing for fixed charges, such as interest and sinking fund, which, on the basis of an assumed life equal to the maturity of the bonds, would amount to 8 per cent of the cost of the plant, or $22,800 per year. This is resolvable into a cost of $1.01 per ton of material treated, to which there must be added, to get the total cost, $0.65444 plus $0.285 (for adjusted labor cost, to say nothing of the adjustments necessary to obtain a fair average of maintenance cost), producing a total cost of $1.9494, which is a higher total cost than obtains in many other cities.

I. S. Osborn,
Vice-President, The C. O. Bartlett & Snow Co.

Cleveland, Ohio
Feb. 10, 1932.

Absolute Volume Proportioning of Concrete

Sir—As the proponent of absolute volume as the basic measure of ingredients in concrete mixtures and in the physics of concrete mixtures generally, I wish to make a constructive criticism of Inge Lyse's stress upon the importance of the weight ratios in his article entitled "Cement-Water Ratio by Weight Proposed for Designing Concrete Mixes," in *Engineering News-Record*, Nov. 5, 1931.

Knowledge of the laws of concrete mixtures is limited and obscure when compared with that in other fields such as cement technology, metallurgy, etc. Although man has employed concrete for possibly 10,000 years and reinforced concrete for 75 years, a law of the strength of mixtures (that involving the Abrams water-cement ratio) was not established until 1918. One explanation of this slow progress is that the ancients naturally employed the very rudimentary bulk volume as the basis of measure of aggregates and cement, and this ancient heritage has been hard to forget. Bulk volume is an indefinite measure, varying from 0.5 to 0.9 in actual (absolute) volume of respective solid ingredients. Lack of understanding of absolute volume as the basic measure of proportions is and has been the barrier to progress in concrete physics.

Some research workers, realizing the futility of bulk volume, have tried weight proportioning. But weight is also an indefinite measure, since it represents merely the attraction of gravity exerted upon the various ingredients; and the specific gravities of the ingredients entering into concrete vary from less than 1 for light-weight aggregates, to unity for water, to 2.7 for common aggregates, to 3.1 for portland cement and to 5.0 or more for heavy aggregates. Weighing is the most accurate *means* of measure, but, as a *basis* of mixture proportions, it is meaningless except in so far as it represents the absolute volumes of the ingredients, as in the case of Mr. Lyse's cement-water ratio by weight.

One of the great advantages of Mr. Lyse's relation of strength to cement-water ratio by weight is that it really measures the effect of the absolute volume of cement in a unit volume of water. As the specific gravities of cement (of a given type) and of water are practically constant in each case, the ratio of cement to water by weight is proportional to the ratio of cement to water by absolute volume for the corresponding strengths. Thus, using Abrams' equation $S = 14000/7^{w/c}$ and assuming that the specific gravity of the cement is 3.105, w/c = cubic feet of water per sack of cement = 62.4 lb. of water per 94 lb. of cement = cubic feet absolute volume of water divided by 0.485 cu.ft. absolute volume of cement. In the accompanying table it is seen that $C1/W1 = 3.105Ca/Wa$,

W/C (Abrams)	Strength	C/W	C_1/W_1 (Lyse)	C_a/W_a (Kitts)
0.5	5,293	2.0	3.012	0.97
1.0	2,000	1.0	1.507	0.485
2.0	286	0.5	0.753	0.2425

which does not change the straight-line relation. The 3.105 is the specific gravity of the cement, and that of water is unity.

Regarding the relative accuracy of the Abrams and Lyse equations, I am inclined to believe that the slight curve of the Abrams equation, when C/W is used instead of W/C, is more true to the facts, for, starting with $C/W = 0$ and making increments of cement to water, the strength first increases at an increasing rate up to a certain concentration of cement, after which it increases at a decreasing rate. This latter decreasing rate from $C1/W1$ = 0.75 to 3.0 is covered by the Abrams' curve. However, a straight line through the practical limits of $C1/W1$ = 1.3 and 2.8, respectively, would not at any point depart appreciably from the Abrams curve. In any event, the one empirical equation is a very valuable adjunct of the other in the solution of the many unknown relations demanding solutions.

It will be found that use of the absolute volume as the basic measure of characteristics of materials and proportions of mixtures simplifies the whole subject of the physics and technology of concrete mixtures, gives simple and convenient methods of analysis and calculation and is the only available basis of predetermination of yield, density, mortar content, etc. With this appreciated, there will no longer be a barrier to scientific knowledge of the laws of concrete mixtures.

Mr. Lyse has made a much-needed and very useful discovery in concrete physics, and this lengthy discussion is made with grateful appreciation of his valuable contribution.

JOSEPH A. KITTS,
Consulting Concrete Technologist.
San Francisco, Calif.,
Jan. 9, 1932.

A Successful Toll Bridge

Sir: I was interested in noting in your Dec. 24, 1931, issue the editorial entitled "It Can Be Done." In 1928 we underwrote the first mortgage bonds and debentures of the Tacony-Palmyra Bridge Co., which was incorporated to construct, own and operate a highway toll bridge across the Delaware River between Tacony, North Philadelphia and Palmyra, N. J. It was expected that this bridge would be completed and put in operation on Jan. 1, 1930. As a matter of fact, construction work was finished and the bridge was opened for traffic in the middle of August, 1929. It has been in successful operation ever since.

We feel that this is one of the outstanding privately owned vehicular toll bridges in this country, occupying a practically unique position among projects of this kind. Gross and net earnings in 1931 before depreciation increased 23 and 29 per cent, respectively, over 1930. Net earnings of $456,493 in 1931 were more than 2.3 times the aggregate annual interest requirements on the first mortgage bonds and debentures outstanding. Total vehicular traffic in 1931 amounted to 1,740,096 vehicles, compared with 1,396,020 vehicles in 1930, an increase of 24.6 per cent. The traffic for 1931 was in excess of the estimate that the engineers (Modjeski, Masters & Chase) made prior to the construction of the bridge for the year 1936.

KENNETH S. MAY.
Vice-President,
Arthur Perry & Co.
Boston, Mass.,
Jan. 21, 1932.

The T-Flange Girder

Sir—The writer has been interested in both the article "T-Flange Girders for Heavy Service" by Messrs. Weiskopf and Pickworth (*ENR*, Oct. 29, 1931, p. 686) and the letter "T-Flange Girders" by James E. Geissberger (*ENR*, Feb. 11, 1932, p. 226). An important difference between them is the greater range obtained by the use of angles in the W-P girders as part of the flange. The net section of a T-flange cut from a 36-in. 300-lb. I-beam with two 8x8x1⅛-in. angles is 72.8 sq.in. With the angles omitted and two 1 1/16-in. holes in the stem, the net section of the T is 41.9 sq.in. The use of angles necessitates fewer coverplates. It often eliminates coverplates, which is an advantage where a clear flange without rivet heads is desired. Also by the use of angles a greater web-rivet capacity can be developed. The web rivets of the W-P girders are in four shears instead of two, as in those shown by Mr. Geissberger. Fewer rivets are thus required. A concentrated load can be brought more directly into the web plates. If four web plates are used, the web rivets are in six shears.

It is doubtful if three lines of rivets, as shown in the stem of the T of Mr. Geissberger's girder (Fig. 3), are ever needed. Two lines of 1-in. rivets closely spaced are sufficient to develop the shearing value of the thickest stem rolled—that cut from a 36-in. 300-lb. I-beam.

Mr. Geissberger mentions the difficulty of straddling columns when it is necessary to use twin girders. If it is practicable to turn 90 deg. the column of his Fig. 2, this difficulty can be made to disappear. The webs of the girders can then frame into vertical connection angles on the outer side of column flanges.

The girders shown in the numbers of *Bautechnik*, utilizing a web plate welded to the stem of a T-flange, and those shown by Mr. Geissberger, using two web plates and T-flanges, have undoubted merit, the latter being an advance over the German girders. The writer believes that a new departure superior to the others is given by Messrs. Weiskopf and Pickworth.

New York City,
Feb. 19, 1932.
ROBINS FLEMING.

Testing Machines of the Bureau of Standards

Sir—In the article in *Engineering News-Record*, Feb. 11, 1932, p. 217, describing the 4,000,000-lb. Southwark-Emery universal testing machine now being installed at the University of California, some clerical error has led to an incorrect statement concerning the large testing machines at the Bureau of Standards. The U. S. Bureau of Standards in Washington is equipped with three large machines:

1. A *horizontal* machine, 2,300,000-lb. capacity in compression and 1,150,000-lb. capacity in tension, taking a 33-ft. specimen in compression and a 27-ft. specimen in tension.
2. A vertical universal machine of 600,000-lb. capacity, taking 30-ft. specimens in compression and 24-ft. specimens in tension and transverse specimens up to 200,000 lb. on a span of 25 ft.
3. A *vertical* compression testing machine of 10,000,000-lb. capacity, taking a specimen 24 ft. long. This machine is equipped with an auxiliary girder, making possible transverse tests up to 1,000,000 lb. on a span of 22 ft.

L. J. BRIGGS.
Bureau of Standards
Department of Commerce
Washington, D. C.,
Feb. 20, 1932.

Superelevation Transition

Sir—Reference is made to *Engineering News-Record*, Jan. 7, 1932, p. 17, in which Oscar V. Hanson describes the use of the reverse-parabolic curve for the pavement edge profile in superelevation transition for pavements. Although this form of transition is still in use in many states, I believe a great many will dispute claims of its superiority.

Observation, experiment or reason will show that the average motorist will, when approaching or leaving a circular curve, make a very close approximation to a constant-change-of-curvature spiral by virtue of his changing the angle of his guiding wheels at a constant rate. Apparently easement cures should be used on all but the flattest circular curves. In any case the superelevation transition should be the same. From some experience in the construction of both types and comparisons made by traveling over both types, it occurs to the writer that a proportional-parts (or straight-line) transition with short parabolic curves at each end to eliminate the "dip" or "bump" is the most satisfactory form of superelevation transition.

In general, the transition profile should have a slope of not to exceed 0.75 per cent with respect to the original grade, in which case short parabolas of 75 ft. or less are sufficient.

For a superelevation designed for resonable speeds it would seem that a transition length of only 100 ft., for a 20-ft. pavement would be inadequate for any but the flatter horizontal curves, regardless of the type of the transition used and the location of the pivot point on the superelevated section. The limit of slope given above would indicate a straight-line transition length of from 150 to 300 ft. for a 20-ft. pavement revolved about the inner edge when superelevated for 35 m.p.h. on curves up to 7 deg., which superelevation is certainly not excessive in view of present trends in motor car manufacture. The straightline transitions should first be computed from zero to a maximum at the P. C. and the P. T. of the circular horizontal curve, and then the short verticals introduced with P. I's at either end of this straight-line transition. If the work is at all times under the supervision of a capable inspector, these short vertical curves may be "eyed in" by form setters without entering into grade computations or staking, since the mid-ordinates will be ¾ in. or less and this type of transition affords ease of computation and staking, comparable to any now in use.

J. CASH BRIDGER.
Neosho, Mo.
Feb. 22, 1932.

NEWS OF THE WEEK

Federal Road-Loan Bill Is Passed By the House

BREAKING over party lines, the House of Representatives on Feb. 27 by a vote of 205 to 109 passed the Almon bill authorizing the appropriation of $132,500,000 for emergency highway construction to increase employment. The bill provides that $120,000,000 be apportioned to the states to be spent before June 30, 1933, and to be repaid in a term of ten years, and that $12,500,000 be applied to improving national park highways, trails and bridges, and roads on Indian reservations. The refund to the federal government by the states is to begin in 1938 by deductions during the following ten years from the regular federal-aid highway appropriations.

Two amendments were made to the bill. One prohibits convict labor and the other provides that labor shall be paid the prevailing wage scale in the various communities as of March 31, 1931.

The bill now goes to the Senate, where it is expected to have much opposition. Should it pass that body opinion in Washington is that the bill faces a veto by the President. This opinion is based on a statement issued by the Secretary of Agriculture Hyde criticising the bill. In his statement Secretary Hyde declares that the bill has more of the aspects of the pork-barrel than of relief from unemployment. He declares that the money provided will give employment directly to only about 35,000, while "by extracting $132,000,000 additional funds from agriculture and industry we shall impose still further strain upon the country and shall deprive more people of employment indirectly than we can employ directly."

◆

Engineers and Architects Agree on Law Changes in New York

Two bills have been introduced into the New York State legislature to amend those sections of the education law that relate to the licensing of engineers and registration of architects. The bills represent the result of extended negotiations between the licensing boards of the two professions, carried forward with the cooperation of the department of education, and now have the unanimous approval of both boards and of the New York State Society of Professional Engineers and the Council of Registered Architects.

The bills are designed to end the differences that have disturbed relations between the two professions for some time, by placing both as nearly as possible on a par as to fundamental educational requirements. The definitions of what constitutes the practice of architecture and of engineering have been rewritten, the latter to make it clear that it covers the design and construction of buildings—a point about which much of the controversy centered. To eliminate another point of controversy, the engineers' law has been changed to include the definite requirement that all engineers who are licensed hereafter must have a knowledge of building design and planning.

◆

No Money for Louisiana Highway Certificates

Holders of certificates of indebtedness of the Louisiana highway commission maturing March 1 will continue to hold them unpaid, according to A. P. Tugwell, chairman, who says that favorable weather has so advanced contract work that revenues accruing from automobile license and gasoline taxes have been diverted from the general highway fund to prevent default. Mr. Tugwell said such default would release bonding companies and obligate the highway commission to an unthinkable extent. The commission has $12,000,000 outstanding certificates. Last October it set aside $4,000,000 to meet partial payments on contracts, but this sum was inadequate. The commission expects to sell $35,000,000 of bonds March 15 with which to redeem certificates and continue work.

◆

Hetch Hetchy Employees Accept Bond Payment Plan

IN ORDER to keep construction operations going on the Hetch Hetchy project, the city of San Francisco had to make further readjustments in financing present work on this project. Because of bond market conditions Hetch Hetchy bonds remained unsold and funds were so badly depleted that shutting down of the Coast Range tunnel operations was imperative unless some arrangement could be made by which the bonds could be used in payment of wages. As a result of a proposal by the city, an agreement has been reached with the 1,300 men working on the Coast Range tunnels, whereby they accept city bonds in payment of wages through the organization of the "Hetch Hetchy Bond Purchase Syndicate." This organization consists of all engineers, office staff and laborers on the Hetch Hetchy project.

The plan of operation is for the syndicate to purchase any or all of the $1,500,000 4½ per cent Hetch Hetchy bonds which were offered for public sale and now remain unsold. A committee has been named to represent the syndicate and carry out the purpose of the agreement. The committee is authorized to borrow money and offer the whole or any part of the bonds purchased as security and to repay such loan from any money received.

According to the plan, the bank buys the bonds from the city at par, thus giving the city cash to pay the wages of the employees. The bank then sells the bonds to the syndicate at a 10 per cent discount. The employees in turn contribute 10 per cent of their monthly salary to the syndicate, which will provide a fund to protect the bank for the 10 per cent discount on the bonds. The plan will be in operation from Feb. 1, 1932, to July 1, 1932, at which time the syndicate will dispose of the bonds at the then current market price. Any profit between the 10 per cent paid to the bank and the sale price of the bonds on July 1 will be divided pro rata among the employees. Any loss resulting from the syndicate operations will be charged against the fund provided by the 10 per cent contribution by employees.

The voluntary action by the employees in accepting this plan and purchasing the bonds automatically relieved the employees of the contribution of one day's pay per month to the city's unemployment relief fund. In reaching this agreement at least 1,300 men will continue steady employment, while, if the plan failed and work had to be discontinued, they would have been out of work. The firms which have been supplying material for this project are also accepting bonds in payment.

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Los Angeles to Vote on $34,400,000 Bond Issue

The board of water and power commissioners of Los Angeles, Calif., has adopted a resolution of intention to ask voters at the city election to be held May 3 to approve a power bond issue of $34,400,000. The board's resolution instructs the city attorney to prepare the necessary resolution requesting the city council to submit the proposition to voters on the ballot.

The bond fund requirements are listed as: $17,500,000 for a transmission line from Hoover Dam, $11,240,000 for a steam plant at Wilmington, and necessary extension and betterments to the existing electric system, $5,660,000.

◆

New York City's 20-Mile Water Tunnel Holed Through

The last heading in the New York City aqueduct No. 2 was holed through on Feb. 22. The tunnel extends for 20 miles from Hill View reservoir in Yonkers to Fort Hamilton Park in South Brooklyn, passing under the boroughs of the Bronx, Queens and Brooklyn at depths from 400 to 700 ft. below the surface. It was driven from nineteen shafts. More than 75 per cent of the concrete lining has been placed and work is well along on placing of riser pipes and control works in many of the shafts. Present indications are that the tunnel will be completed more than a year ahead of schedule. Patrick McGovern, Inc., has the contract for the entire work, totaling $43,000,000

Wisconsin Society May Join Municipal Engineers

Amalgamation of the Engineering Society of Wisconsin with the American Society of Municipal Engineers, as a local chapter of the latter, was a radical proposition made by T. Chalkley Hatton at the recent annual meeting of the Wisconsin society, at Madison, Wis., with the result that a letter ballot is to be taken.

Among the papers and reports delivered at the meeting was one by the committee on materials stating that refinements in the practice of making concrete, as developed in the highway materials laboratory of the University of Wisconsin, saved the state $322,560 on pavement construction during 1931. For coarse aggregates from different parts of the state proportions are varied to suit the character of the material, with a considerable saving in cement.

The Wisconsin typhoid death rate during 1931 was down to 0.7 per 100,000, as shown by L. F. Warrick, sanitary engineer for the state board of health. Recent developments in water purification in the state have been the control of tastes and odors by means of chlorine-ammonia treatment and the use of activated carbon, providing better aeration and mixing facilities for coagulants at filtration plants, and improving the chemical characteristics of water supplies through the installation of iron and manganese removal and water-softening equipment. Wisconsin now has a total of 299 municipalities or communities provided with public waterworks systems.

Surveying problems brought out much discussion, particularly in regard to the proper monumenting of new plats. One group favored marking every corner of every lot and the critical points on curves, while another group contended for the monumenting of block corners only.

A registered attendance of 138, or 40 per cent of the membership, was considered surprisingly good in view of business conditions. Officers elected include: president, H. C. Webster, civil engineer, Milwaukee, Wis.; vice-president, Prof. G. L. Larson, University of Wisconsin; secretary (re-elected), Prof. R. S. Owen, University of Wisconsin, Madison, Wis.

Engineers Named to Make Study of Flood Control

THREE eminent engineers are to comprise a board which will be in charge of a review of the engineering features of the Mississippi flood-control project. The chairman is Col. Harley B. Ferguson, in charge of the South Atlantic Division for the Corps of Engineers. The other military member of the board will be Col. George R. Spalding, division engineer for the upper Mississippi Valley. The board will have a civilian member in the person of Anson Marston, dean of engineering at Iowa State College and past-president of the American Society of Civil Engineers.

Riley J. Wilson, chairman of the flood-control committee of the House of Representatives, was advised March 1 by the secretary of war of the appointment of this board, which was created under a resolution written by Mr. Wilson and adopted unanimously on Jan. 29 by the committee on flood control. The resolution provides for a review of the engineering features of the project, with a view of determining what changes or modifications should be made.

The secretary and administrative officer of the board will be Capt. John Paul Dean, now at New Orleans. While the resolution does not limit the study, it is known that it will be devoted largely to the consideration of an increase in the carrying capacity of the main river below the Arkansas and to the study of the problems in the Atchafalaya Basin.

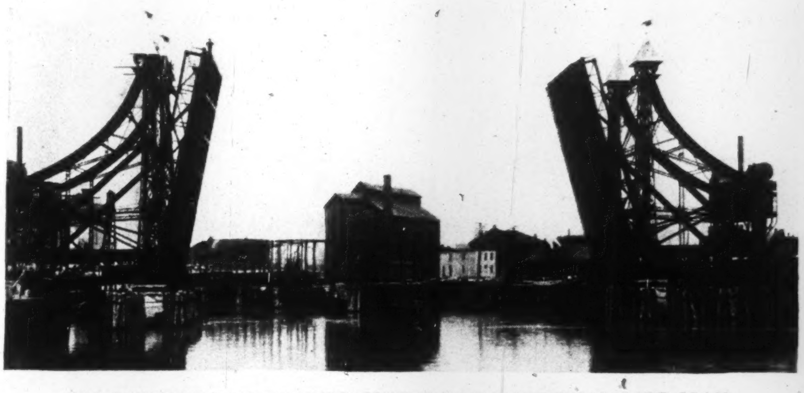
◆

New Garbage Incinerator for Portland, Ore.

A garbage incinerator with a capacity of 150 tons in sixteen hours, has been ordered by Portland, Ore., for its second incinerator unit and is to be installed on the new 300-acre site north of St. Johns. The D.-N. Corp. was awarded the contract for the installation at $131,432. Three circular furnace units of 50-ton capacity each with preheating devices are to comprise the installation.

A special feature of the new incinerator is the arrangement for ash handling, the ash being automatically fed to trucks, which will dump it on low-lying swampy land included in the 300-acre site.

Part of the original $300,000 authorization for incinerators is still available for the possible installation of a third unit in the southeastern section of the city, which, if it is installed, will materially reduce the average length of haul.



OLD BASCULE BRIDGE WILL GIVE WAY TO VERTICAL LIFT SPAN

This double-leaf bascule span carrying Michigan Ave. over the Buffalo River at Buffalo, N. Y., built in 1896, is to be replaced by a vertical-lift bridge of greater load capacity and longer span. The bascule is of the Brown type, with counterweights rolling on curved tracks on the approach spans. The new bridge was designed by Edward P. Lupfer, consulting engineer, in cooperation with John T. Mockler, acting city engineer. The contract, at $509,000, was awarded to the Wisconsin Bridge & Iron Works, Milwaukee, Wis., which firm built the old structure 36 years ago, as described in detail in *Engineering News-Record* of Aug. 19, 1897, p. 125. This photograph was taken in 1896.

◆

Air-Mapping Patents Pooled

Incorporation of the Institute of Photogrammetry, Inc., as a patent holding company in the aerial photographic mapping field is announced. The new concern has acquired among others Patent 1,331,978, held by Brock & Weymouth, on which patent this firm brought suit against the Fairchild Aviation Corp. The new concern has licensed both Brock & Weymouth, Inc., and Fairchild Aerial Surveys, Inc., under all the patents it owns and controls.

◆

Materials Handling Institute to Hold First Meeting

The newly organized Materials Handling Institute, representing manufacturers of conveying and handling apparatus, will hold its first regular meeting May 2 at Philadelphia in conjunction with the materials handling division of the A.S.M.E. The industry has been divided into the following groups: (1) hoists and cranes, (2) gravity conveyors, (3) continuous conveyors, (4) bulk, portable and pneumatic conveyors, (5) floor trucks, (6) lift trucks and portable elevators, (7) industrial tractors and trucks, (8) transmission apparatus, (9) locomotive and crawler cranes and industrial locomotives, (10) monorail apparatus, (11) accessories. The president of the institute is Frank E. Moore, president, Mathews Conveyor Co., Elwood City, Pa.

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Hoover Dam Notes

Practically no progress was made in the 41x56-ft. tunnels at Hoover Dam during the week ended Feb. 20. Work during the week was confined largely to unwatering the diversion tunnels and removal of silt and muck carried into the tunnels by the flood in the Colorado River which reached its peak Feb. 12. The maximum flow of the river was 57,000 sec.-ft.

* * *

Trimming operations in the tunnels were resumed. Excavation for the removal of the invert sections of the diversion tunnels was started Feb. 19 at the inlets of tunnels No. 1 and No. 2. Driving of the 7x10-ft. pilot bores in the inclined spillway tunnels was continued. Sixty feet of progress was made during the week on the Nevada inclined tunnel. Thirty feet of work was done in the Arizona tunnel. Because of the flood it was possible at the end of the week to utilize only 1,400 of the 3,000 employees.

* * *

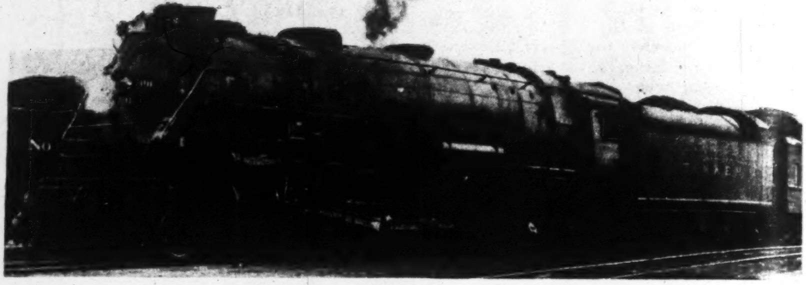
Since Aug. 1, 7.32 inches of rain has fallen in Las Vegas. The average annual rainfall there is 2.75 in.

New Move Started to Stimulate More Public Works

RECOGNIZING that all the efforts of the committees set up to provide relief work for unemployed engineers are being put to nought by the present movement to stop or greatly curtail all public-works construction, the Professional Engineers Committee on Unemployment, New York, has set up a subcommittee to determine means for stimulating public construction. The committee, known as the Committee on Construction Legislation, is headed by Malcolm Pirnie and John P. Hogan.

After a study of the present situation in regard to public construction the committee has come to the conclusion that the problem is a national one, that cities and counties and to some extent states are unable to finance much public construction; that if an effective amount of work is to be undertaken it must be financed by a federal agency similar to the Reconstruction Finance Corp.

Because of the national aspect of this problem the committee has held informal discussions with representatives of the American Legion and the American Federation of Labor to determine whether the plans it is formulating will tie in with those of either of these two large organizations, both of which have indorsed an enlarged program of public works. It is the committee's belief that engineers can provide a definite program of public works now held up but ready to be put under way at short notice.



LOCOMOTIVE COMPLETES 100,000-MILE TEST

After operating on fourteen different railroads since it was put into service in April, 1930, the first locomotive ever to be equipped with anti-friction bearings recently pulled into the Seattle terminal of the Northern Pacific Railroad at the termination of the run which completed its initial test period of 100,000 miles. During the test period it operated from coast to coast under every conceivable condition of climate, temperature, terrain and trackage, hauling the heaviest freight trains and the fastest passenger trains. It was in service on the New York Central; Pennsylvania; Chesapeake & Ohio; Erie; New York, New Haven & Hartford; Boston & Maine; Delaware & Hudson; Lackawanna; Lehigh Valley; Nickel Plate; Chicago & Alton; Missouri Pacific; Chicago, Burlington & Quincy, and the Northern Pacific. During the entire test period not a single instance of bearing trouble was recorded. Tests show that the anti-friction bearings increase locomotive tractive effort considerably when starting trains. The locomotive was designed by the Timken Roller Bearing Co., Canton, Ohio, and was built by the American Locomotive Co., New York City, to demonstrate the ability of the locomotive with anti-friction bearings.

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Iowa Engineers Discuss Governmental Problems

Municipal and governmental policies were dealt with in a series of papers at the annual meeting of the Iowa Engineering Society, held at Cedar Rapids, Iowa, jointly with the Iowa section of the American Society of Civil Engineers and the annual surveyors conference.

In a paper on "Engineers and Tax Problems" L. M. Hintgen, chief engineer of Sioux City, argued that a more equitable adjustment of the tax burden is essential before further extensive public improvements can be successfully worked out. P. F. Hopkins, city manager of Mason City, stated that ten cities in Iowa have the city manager system. A paper by G. M. Griffith on "County Government and the Engineer" pointed out that the return of many counties to day-labor methods of construction is due to refusal of county supervisors to employ adequate engineering service and to vigorous sales campaigns by equipment manufacturers. As the value of engineering service is being determined by advertising for bids, the question was raised as to how engineers can expect to be treated as professional men while they insist upon classifying their services as a commodity. Much interest was evident as to the action of counties in calling for bids for engineering services and a resolution was passed to the effect that bidding for such work is unethical.

A new system of intercepting sewers for Cedar Rapids was described by Howard R. Green, while J. D. Wardle reported that there is a movement to obtain a repeal of the sewer rental law at the next meeting of the legislature.

Officers for 1932 include: president, G. M. Griffith, county engineer, Iowa City; vice-president, J. R. Maher and C. C. Williams; secretary (reelected), J. S. Dodds, Iowa State College, Ames, Iowa.

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Railroads Protest Changes in Illinois Bridges

Proposed requirements of changes in four railroad bridges over the Illinois Waterway to give 110-ft. channel width and a headroom of 47 ft. instead of the existing 20 to 28 ft. headroom are opposed by the railways as unnecessary and unduly expensive. These changes are proposed by the federal government, which has taken over the unfinished waterway from the State of Illinois. For the barge traffic which this 9-ft. channel is designed to carry a 20-ft. headroom is considered ample. The greater height would be needed by only a few steamers of the old type with tall smokestacks, and these the railroads claim could pass the bridges with hinged smokestacks and lower pilot houses. At a public hearing in Chicago before representatives of the U. S. Engineers, the total cost of reconstruction was estimated at $2,335,000 and $1,690,000 for fixed and lift bridges, respectively, while operation of the latter would amount to nearly $40,000 annually.

Similar opposition is made by seven railroads to proposed requirements for alterations to bridges over the Chicago drainage canal, which is the approach to the waterway. Here 25-ft. headroom and 200-ft. channel are to be required, while the railroads consider 18½ ft. and 120 ft. as ample, or two 60-ft. channels at center-pier bridges. The city objects to the 25-ft. headroom in view of its possible relation to future fixed bridges over the Chicago River.

Twin Cities Agree on Plans for Sewage Disposal

The Metropolitan Drainage Commission of Minneapolis and St. Paul on Feb. 13 accepted the recommendations of J. A. Childs, chief engineer, supported by the consultants, Frederick Bass, University of Minnesota, and A. S. Milinowski, consulting engineer, St. Paul, to locate the main interceptor along the so-called St. Anthony Ave. route through St. Paul. This interceptor will be a 14-ft. tunnel carrying all the Minneapolis sewage and part of St. Paul's sewage to the proposed site of the treating plant at Pigs Eye Lake, lying south of St. Paul, a lake which has now disappeared because of the Hastings Dam. This tunnel will be approximately 200 ft. below the residential portion of the city.

The legislature of 1931 established a metropolitan drainage district consisting of Minneapolis, St. Paul, South St. Paul and Newport with provisions for the issuance of bonds, letting of contracts, etc. This legislation was vetoed by Gov. Olson in the last days of the session on the ground that it was unfair to Minneapolis (*ENR*, April 30, 1931, p. 743, and June 18, 1931, p. 1025). It is now expected that the commission will have complete plans to present to the 1933 legislature and that construction will proceed immediately after the enactment of an enabling act, which has practically been agreed upon by the two cities.

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W. D. Coolidge Receives Washington Award

For the many important electrical developments by William D. Coolidge, of the General Electric Co., the Washington award for 1932 has been conferred upon him by a commission repesenting the five largest engineering societies. The presentation was made at Chicago Feb. 24 at a special meeting of the Western Society of Engineers.

Baltimore's Smoke Control Advisory Board Named

Mayor Jackson, of Baltimore, has sent to the city council for confirmation the names of five men to serve on the unsalaried advisory and appeal board authorized by the city's smoke-control ordinance, which goes into effect May 13. The board is designated by the ordinance as "an agency for adjudicating the various technical and economic problems that occur in the formulation of the type and kind of supervisory control to be exercised by the commissioner for smoke control over new and remodeled installations of combustion equipment in so far as the emission of smoke to the atmosphere is concerned." It will act as an appeals body in disputes between smoke-control officials and those affected by rulings of these officials.

Prof. A. G. Christie, of Johns Hopkins University, is preparing specifications on which tests are to be conducted to determine fitness of candidates for an eligible list from which an assistant commissioner and inspectors are to be appointed. Norman W. Hill is acting commissioner of the smoke control bureau, which is a unit of the city's department of public works.

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Tunnel Under Vancouver Nearly Completed

The Canadian Pacific Railway Co.'s 4,600-ft. tunnel under the city of Vancouver, B. C., between Burrard Inlet and the company's yards at False Creek will hole through early in April and will be completed by June at the present rate of progress. The concrete lining has been completed 3,304 ft. in from the east portal. Concrete footings are in place 276 ft. in advance of the lining. Excavation to grade has now been completed 3,810 ft. in from the east portal.

The Northern Construction Co., Ltd., and J. W. Stewart, Vancouver, are doing the construction, the cost of which is estimated at $1,750,000.

Engineers Discuss Drainage and Flood Control

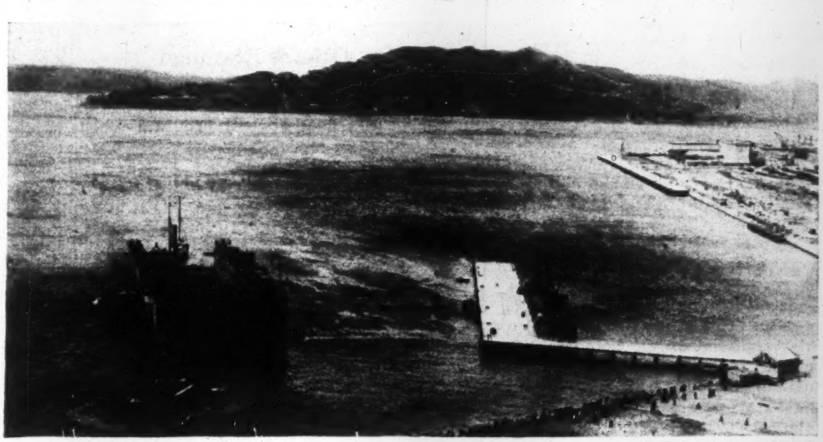
ENGINEERING and economic aspects of hydraulic matters involving public interests and policies were prominent at the 21st annual meeting of the National Drainage Conservation and Flood Control Congress, held recently at Louisville, Ky. Small attendance was in marked comparison with former large meetings. The presidential address by B. F. Williams, state reclamation engineer of Texas, reviewed briefly the status of such prospects as the Colorado River (Hoover Dam), the Atlantic and Gulf intracoastal canals and the Rio Grande negotiations with Mexico, together with some Texas developments in drainage and flood control.

Protection of Pittsburgh from floods by the Pymatuning reservoir and dam was described by E. K. Morse, of the Pennsylvania Water and Power Resources Board. Amout 25,000 acres have been purchased, of which 16,700 acres will be submerged. Clearing and other preliminary work is being done by day labor as a relief project. The earth dam and its spillway will be 2,400 ft. long, with a height of 25 to 50 ft.

Effects on drainage districts and river towns by the creation of a 9-ft. channel in the Mississippi above St. Louis were discussed by C. H. Young, consulting engineer, Muscatine, Iowa. The 26 dams will raise the pool levels 8 to 14 ft., causing damage due to backwater, seepage, obstruction of gravity outlets and increased cost of pumping. These burdens, Mr. Young argued, should not be laid upon towns and drainage districts without compensation, but legal difficulties make such compensation seem doubtful. Conflicting interrelations of drainage, flood control and inland navigation were reviewed by J. A. Harman, consulting engineer, Peoria, Ill., who took the Ohio, Mississippi and Illinois rivers as examples.

Financing of public drainage indebtedness by the federal government was advocated by E. V. Willard, Minnesota state commissioner of drainage and waters, who outlined a bill now in Congress for the relief of drainage and irrigation districts by government loans. Conservation work of the Indiana state department of conservation, as presented by Denzil Doggett, assistant state engineer, includes reservoir construction and forestry, with problems of providing safe and adequate water supplies in the state parks and forest areas. Causes and effects of the severe drought conditions of 1930 were discussed in a paper by C. R Knowles, superintendent of water service, Illinois Central R.R.

Engineers are prominent among the officers elected. The president is E. V Willard, state water and drainage commissioner, St. Paul, Minn.; vice-presidents are O. C. Kulicka, drainage engineer, Greenville, Miss., and L. Mims, Freeport, Tex.; directors, Denzil Doggett, assistant state engineer, Indianapolis, Ind.; F. M Bruner, U. S. district forester, Louisville, Ky.; W. G. Potter, state drainage engineer, Chicago, Ill., and B. F. Williams, state reclamation engineer, Austin, Tex.; the treasurer is E. G. Jacques, American Steel & Wire Co., Kansas City, Mo.; secretary, T. W. Vinson, Louisville, Ky.


Keystone-Underwood Photo

FLOATING DRYDOCK TOWED FROM ENGLAND TO NEW ZEALAND

The Wellington, New Zealand, harbor board's floating drydock has reached its destination after 166 days at sea in a 13,627-mile tow from the Tyne River, England, where it was built. The course was through the North Sea, English Channel, Bay of Biscay, Straits of Gibraltar, Mediterranean Sea, Suez Canal, Red Sea, Indian Ocean, Arafua Sea and Tasman Sea. The voyage began on July 15, 1931, and the dock was towed into Wellington harbor Dec. 28, 1931, and placed in position on the following day.

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Los Angeles County to Build Bridges to Aid Flood Control

The board of supervisors of Los Angeles County, Calif., has voted appropriations totaling $350,000 for bridge construction in connection with county flood-control projects. Twenty-three permanent wooden bridges will be constructed across Big Tujunga Wash, the mouth of Big Tujunga Canyon, at a cost of $35,000. E. C. Eaton, district flood-control engineer, recommended the construction as a means of greater utilization of water spreading grounds at the canyon's mouth. At present it is possible to spread about 20 acre-ft. of water at a time, more than this causing flooding of roadways. With the proposed bridges in service, spreading may be increased to about 200 acre-ft.

From flood-control reserve funds $315,000 was appropriated for construction of a railroad bridge across the flood-diversion channel east of Southgate, south of Los Angeles. The funds will be replaced with next year's state flood-control appropriation. Part of the cost of the railroad bridge, estimated at $465,000, will be paid by the Union Pacific Railroad.

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Mineral Research Program of Illinois Geological Survey

A program of mineral research has been inaugurated by the Illinois State Geological Survey under the leadership of M. M. Leighton, chief of the division. The program provides for a complete scientific investigation into the composition and potential economic possibilities of all mineral and rock substances occurring in Illinois, and also for the study of production and movements of mineral materials both into and out of the state, and of all possible marketing opportunities. The Survey's staff has been greatly enlarged in order to pursue the researches, which will be carried on in the new mineral research laboratories of the University of Illinois at Urbana.

Regional Plan for North Jersey Is Recommended

In its annual report to the governor and legislature of New Jersey the state regional planning commission recommends creation of a proposed North Jersey Metropolitan Regional District, including eight counties, with a borrowing power of $80,000,000, which would finance an elaborate public-works program. Enactment at the present legislative session of the regional district bill and reference of the whole question to the north Jersey voters at the fall election are advised.

Public works which the commission says are greatly needed are: a unified north Jersey water-supply system to serve all municipalities on equal terms, a comprehensive metropolitan system of sewerage and drainage, a modern rapid-transit system connecting north Jersey population centers with one another and with Manhattan, and reclamation development and utilization for industrial and residential purposes of 40,000 acres of waste marsh.

In order to settle all doubts as to the constitutionality of the proposed measures, the commission recommends reference to the voters of a proposed constitutional amendment empowering the legislature to create intermunicipal and intercounty improvement and public-works districts.

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Committee Formed to Study Street Maintenance

Representatives of nine nation-wide organizations of public-works officials and research agencies convened in Detroit in January during the annual convention of the American Road Builders' Association to initiate an intensive study in street maintenance economics. George B. Sowers, commissioner of engineering and construction of Cleveland, Ohio, and the representative of the American Road Builders' Association on this committee, was elected chairman. Other members of the committee and the organizations they represent are:

C. C. Ludwig, Albert Lea, Minn., International City Managers' Association; H. M. Waite, Cincinnati, National Committee on Municipal Standards; J. E. Root, Cincinnati, Ohio, American Society of Civil Engineers; P. L. Brockway, Wichita, Kan., American Society of Municipal Engineers; Robert B. Brooks, St. Louis, International Association of Public Works Officials; Carl H. Chatters, Detroit, Mich., International Association of Comptrollers and Accounting Officers; William J. Locke, San Francisco, American Municipal Association; Robert M. Goodrich, Duluth, Minn., Governmental Research Association.

Standard methods of controlling street maintenance operations, for measuring the amount of work done and its cost, of accounting for expenditures and of preparing street maintenance work programs and budgets will be formulated as an aid to street maintenance engineers. One of the first activities of the committee will be to design a record and cost system to aid city officials in determining when streets should be repaved. A model appropriation and accounting scheme will be developed to aid street maintenance engineers in avoiding overexpenditure of city appropriations.

The work of the committee, which has been named the National Committee on Street Maintenance Economics, is financed and staffed jointly by the American Road Builders' Association and the Research Committee of the International City Managers' Association. P. F. Sewart, National Press Building, Washington, D. C., and Donald C. Stone, 923 East 60th St., Chicago, are jointly in charge of the staff of this committee.

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Washington Notes

By Paul Wooton

Washington Correspondent

In order to carry on public building work at as high a rate as possible, the House appropriations committee has allowed an increase over last year in the total amount to be made available to the supervising architect's office for the fiscal year 1933. Last year the total appropriation was $107,415,930. In reporting out the treasury department appropriation bill the committee has raised this amount to $133,406,930. A cut of $12,785,840 was made, however, under the estimates of the budget bureau.

In setting aside $108,000,000 for sites and construction of buildings, the committee has limited the amount that may be spent in the District of Columbia to $15,000,000 and specifically prohibits the use of any of the funds in reconstructing the State, War and Navy Building or for commencing work on the apex building in the triangle area.

Scope of Public Building Work

Statistical information submitted to the committee shows that as of Jan. 1, 1932, 142 projects had been completed at a total cost of $44,101,569. There are 293 projects under contract either in whole or in part at present, to cost when completed $235,368,700. Specifications are now being drafted or jobs are on the market for bids on 72 projects involving a cost of $30,487,500. In addition, the office of the supervising architect is now drawing plans for 106 projects which altogether will cost $13,866,900. Plans are also being prepared by private architects for 156 projects to cost $124,775,023.

Glass-Steagall Act

The Glass-Steagall emergency banking bill passed differs from both the Senate and the House bill. It extends the privilege of borrowing individually on non-eligible paper to banks having not more than $5,000,000 capital; the original proposal excluded all banks with more than $500,000 capital. The $5,000,000 limit will exclude only 70 banks, all in cities where it will be relatively easy to form a five-bank group. The bill also requires the approval of only five members of the Federal Reserve Board for loans, instead of the original unanimous vote and the later approval of six members. By amending the federal reserve act provisions with regard to collateral the emergency bill makes it possible for banks to meet an internal currency drain, or a drain on gold from abroad, without putting member banks into debt.

The effect of the legislation is to allow banks that are members of the Federal Reserve System to pledge securities other than eligible paper. There is a penalty rate and other special safeguards in the new legislation. It authorizes the use of government securities as collateral against Federal Reserve notes. This latter provision simply corrects a flaw in the original act. When the act was drafted its framers foresaw the possibility of a time when there would not be enough gold. For that reason they provided for the suspension of the reserve requirement in an emergency. It seems never to have occurred to them, however, that there might come a time when there would be a shortage of eligible paper which would necessitate the impounding of large additional amounts of gold above the 40 per cent reserve requirement of the law. Because of the shortage of commercial paper it became necessary to increase the gold reserve to nearly 80 per cent of the outstanding currency. It took this law to authorize the Federal Reserve Board to release any part of the gold reserve.

What the R.F.C. Has Done

In less than a month after Congress established it, the great national credit bank represented by the Reconstruction Finance Corp. was set up and in operation, and the last emergency application had been handled. A week later all accumulated applications had been acted upon and the work put on a current status.

Many of the applications for loans which were being pressed when the board was organized have since been withdrawn. Many of the earlier loans already have been repaid. In one instance a bank borrowed a million dollars and repaid the loan five days later. When it became apparent that the bank was able to meet certain pressing demands being made upon it, confidence was restored and sufficient money to conduct all business became available from other sources. The total number of applications is materially less than had been expected. The greatest surprise, however, has been the relatively few emergency applications that have had to be handled.

The board requires a total personnel of some 200 persons. A considerable proportion of that number had to be drafted from other agencies because of specialized knowledge. As a consequence it had only 150 places to fill from those who applied for employment. There were more than 40,000 applications for those 150 places.

New Orleans Reassured

New Orleans interests are insisting on substantial compliance with the provision of the flood-control program which specifies that the floodwaters of the Mississippi River shall not exceed 20 ft. on the Carrollton gage. Because the lines of three railroads and a main highway still are occupying their original positions on the floor of the Bonnet Carré spillway, the secretary of war and the chief of engineers are not anxious to incur the damages which will result were the spillway operated at this time. For that reason they are not willing to promise to open the spillway the minute a stage of 20 ft. is attained.

Both Secretary Hurley and Gen. Brown have given assurances that the spillway will be opened if any danger threatens New Orleans. Gen. Brown has made arrangements to be on the scene should it become evident that there will be a stage in excess of 20 ft. This could happen only as a result of unusually heavy rains in the Yazoo or Red river basins.

Brief News

Teachers of English in engineering colleges of the United States are invited to a special school to be held July 11-28 at Ohio State University, Columbus, Ohio. The school is sponsored by the Society for the Promotion of Engineering Education.

An Injunction has been granted by the New Jersey court of chancery upon application of the state board of health restraining the city commissioners of Asbury Park from discharging improperly treated sewage into the Atlantic Ocean after April 1.

Expenditure of $5,000,000 for a building program has been approved by the board of trustees of the College of Puget Sound, Tacoma, Wash. The program will cover a ten-year period and $2,000,000 is now available.

Seven Engineers, the entire staff on the payroll of Santa Monica, Calif., were to be laid off Feb. 27. This action was made necessary, according to Howard Carter, city engineer, by lack of work under existing retrenchment conditions.

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Personal Notes

Roy Klein, chief engineer of the Oregon state highway department for the past eleven years, has resigned and has been succeeded by R. H. **Baldock**, his former principal assistant.

George B. Sowers, commissioner of engineering and construction of Cleveland, Ohio, has been dismissed by Mayor Miller in a reorganization of departments following the recent rejection of the city manager form of government.

Peter C. Bullard, major, Corps of Engineers, has been relieved from duty in the office of the district engineer, Duluth, Minn., and has been assigned to the General Staff School at Fort Leavenworth, Kan., as instructor.

William D. Beers, secretary of the Utah-Colorado river commission, has been appointed city engineer of Salt Lake City, to succeed Harry C. Jessen. Mr. Beers formerly was state engineer and engineer for the state road commission.

George W. Fuller, of New York City, consulting engineer and former vice-president of the American Society of Civil Engineers, has been chosen first vice-president of the Engineering Foundation.

R. C. **Terrell**, of Bedford, Ky., has been appointed engineer of tests in the laboratory of the Kentucky state highway department, succeeding R. C. Haff, of Mount Vernon, who resigned last fall. Mr. Terrell was chairman and engineer of the first highway commission of Kentucky and for several years was engineer of the Oklahoma highway department.

The firm of Robert Sayre Kent, Inc., consulting engineers, Brooklyn, N. Y., announces additions to its directorship as follows: **Frederick Siefke**, as vice-president and manager; **John H. Miller**, as secretary and chief engineer; **Edward E. Chapin**, as assistant treasurer and chief chemist.

Obituary

Howard Edward Boardman, Dudley professor of railroad engineering in the Yale graduate school, died of pneumonia on Feb. 28 at his home in New Haven. Mr. Boardman was the first incumbent of the professorship, the purpose of which was to instruct graduate students in methods of meeting the railroad problems caused by new fields of competition. Instruction of students had not yet started, Prof. Boardman having devoted the first months of his incumbency to thorough study of the situation. Prof. Boardman was born in Meriden, Conn., in 1879, and was graduated from Sheffield scientific school of Yale in 1899. In 1900 he joined the engineering forces of the Pennsylvania Railroad, and from 1902 to 1909 was engaged in the construction of the tunnels for that railroad under the Hudson River. From 1909 to 1912 he was with the Missouri Pacific Railroad and from 1912 to 1916 was in Buenos Aires as chief assistant engineer of the Buenos Aires Western Railway in the construction of tunnels for passenger and freight trains and a subterranean station in the city. He returned to the United States in 1916 and became engineering assistant to the general valuation counsel of the New York Central Railroad, remaining there until 1923, when he became president and treasurer of Foster Merriam & Co., of Meriden, Conn., and later construction engineer of the Boston & Maine Railroad.

Clifford Richardson, an authority on asphalt and from 1900 to 1910 in practice in New York under the name of the New York Testing Laboratory, died on Feb. 28 in Paris, aged 75. He had charge of laying asphalt pavements in many cities in this country and abroad and for many years was expert for the Barber Asphalt Co. and other companies.

Otto von Geldern, consulting engineer and president of the Mechanics Institute of San Francisco, died on Feb. 17 at his home in San Francisco. Mr. von Geldern was born in Germany 79 years ago and went to California in 1864. He was associated with many engineering projects in California. He was a consulting engineer in the construction of the Sacramento-San Juan reclamation project and supervised the construction of the San Pedro breakwater in Los Angeles harbor. Mr. von Geldern was an ex-officio member of the board of regents of the University of California and vice-president of the California Academy of Sciences.

Henning Fernstrom, retired civil engineer, died in Norfolk, Va., Feb. 26 at the age of 75. Mr. Fernstrom was born and educated in Sweden, but came to this country in 1880. After working as a draftsman in an engineer's office in Boston he became assistant engineer in the construction of the Minnesota & Northwestern Railway's bridge across the Mississippi River at St. Paul. From 1885 to 1890 he was chief engineer of the Chicago Great Western. In 1901 he was made principal assistant engineer of the New York Central & Hudson River Railroad and in 1905 became chief engineer of the Virginian Railway, a position which he held until his retirement in 1927.

George E. Higgins, of Syracuse, N. Y., a graduate in civil engineering from Cornell University, died suddenly on Feb. 25 in his 70th year. Mr. Higgins was in the city engineer's office in Syracuse during 1888-89 and since that time had been in general civil engineering practice in Syracuse.

George E. Leighton, of Montreal, president of the Canadian Steel Society and the British Manufacturers Association, died on Feb. 23, aged 54 years. Mr. Leighton was born in England and was graduated at Sheffield University as an engineer.

William T. Walker, construction superintendent, Northern States Power Co., died of uremic poisoning Feb. 25 at Grand Forks, N. D. Mr. Walker was born in 1874 and was graduated from the University of Kansas in 1897. He became associated with the Byllesby Engineering & Management Corp., of which the Northern States Power Co. is a unit, in March of 1910 and since that time had been active as construction superintendent for a number of projects.

SOCIETY CALENDAR

AMERICAN RAILWAY ENGINEERING ASSOCIATION, annual convention, Chicago, March 15-16.

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting, Atlantic City, June 20-24.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual convention, Yellowstone National Park, July, date to be fixed.

AMERICAN WATER WORKS ASSOCIATION, annual convention, Memphis, Tenn., May 2-6.

AMERICAN WELDING SOCIETY, annual meeting, New York City, April 27-29.

CONCRETE REINFORCING STEEL INSTITUTE, eighth annual meeting, March 7-9, Atlanta, Ga.

NEW ENGLAND SEWAGE WORKS ASSOCIATION, annual meeting, Boston, April 25.

MICHIGAN ENGINEERING SOCIETY at its annual meeting at Kalamazoo, Mich., Feb. 22-23 elected: president, George M. Ames, Grand Rapids; vice-president, C. M. Ziegler, deputy state highway commissioner, Lansing; secretary, Andrew Lenderink, consulting engineer, Kalamazoo, Mich.

NATIONAL ASSOCIATION OF BUILDING TRADES EMPLOYERS, 228 North LaSalle St., Chicago, will hold a meeting at St. Louis, Mo., March 23.

NEW YORK STATE SOCIETY OF PROFESSIONAL ENGINEERS held its winter meeting at Albany, N. Y., on Feb. 27 with 106 members present. The greater part of the meeting was devoted to the consideration of legislation affecting the profession, chiefly extensive amendments to the engineer license law, to indorsing bills designed to continue essential services such as stream gaging and to expressing opposition to cuts in appropriations for public works. Present estimates indicate that 600 engineers and 200 architects will be thrown out of work by cuts now ordered in appropriations. Despite unemployment in the profession, the society had an increase in membership during the year of 333, bringing the total to 1,938. Charters were granted to two new chapters, Rensselaer County and Schenectady County.

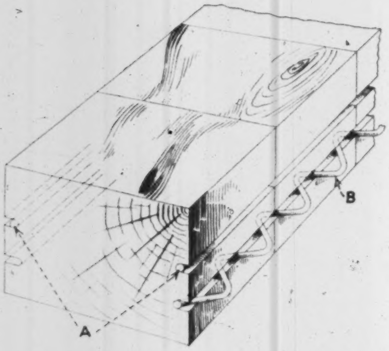
ONTARIO GOOD ROADS ASSOCIATION held its 30th annual convention in Toronto Feb. 24-25, with an attendance of about 400. The association went on record as approving an additional tax on gasoline.

WESTERN SOCIETY OF ENGINEERS, Chicago, has nominated officers for 1932-1933: president, D. J. Brumley, chief engineer of Chicago terminal improvements, Illinois Central R.R.; vice-presidents, H. B. Gear, Commonwealth Edison Co.; C. C. Whittier, Robert W. Hunt Co., and Leigh S. Keith, consulting engineer.

Construction Equipment and Materials

Wood Block Flooring Built Up in Flexible Strips

Wood blocks bound together by wire trusses into strips 6 ft. long form a new type of flooring introduced by the Jennison-Wright Co., Toledo, Ohio. The blocks in this flooring, another of the company's Kreolite line, are laid with the tough end grain up, and are treated with a waterproofing preservative, a colorless and odorless oil. Manufactured from properly dried yellow pine, the blocks are bound together in flexible strips with the metal wire trusses in such a way that the individual units cannot become loose and the surface cannot become rough. The wires binding the blocks into strips fit into grooves cut in the sides of the block. In another grove, cut below the first, are placed metal splines which bond adjacent strips. A smooth, durable floor is provided by laying strips in mastic over a smooth concrete base. The light color of the new-type flooring will be desirable where former blocks treated with a dark creosoted oil have not been attractive.



Wood block flooring bound in strips. *(A)* Wire truss winding individual blocks into flexible strips. *(B)* Metal splines provide bonds for adjacent strips.

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Zero-Pressure Rubber Tires

A zero-pressure rubber tire especially for tractors and trailers has been designed by the B. F. Goodrich Rubber Co., Akron, Ohio. The tire is of all-rubber construction and is designed with an air chamber, although no air pressure is used. It is built with a wide tread to provide maximum traction. It is claimed the new tire will give a constant traction over any type of soft ground or through mud and in addition provide a cushioning effect that deadens all jars and impacts. The new tire was developed to meet the need of a tractor tire that would give more traction than solid tires, a tire without the hazards of pneumatics, and a tire that would not be barred from the highways.

Cross-section of Goodrich zero-pressure tire.

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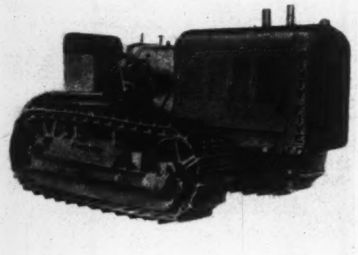
Larger Tractor Added to Caterpillar Line

The Caterpillar Tractor Co., Peoria, Ill., has enlarged its former model 60 into a new model 65, which becomes the largest tractor in the Caterpillar line. The old model 60 has been discontinued. The new Caterpillar line, entirely rebuilt or improved, includes: the Diesel, the 65, the 50, the 35, the 25, the 20, the 15 and the high clearance models.



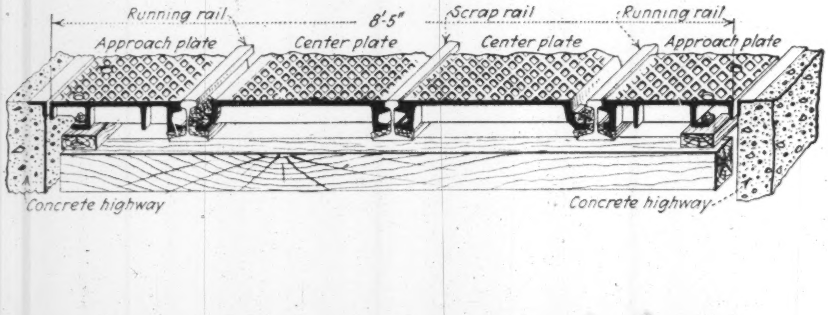
The 65 is a new size in the Caterpillar line.

◆

Steel Plate Highway Crossing

Heavy ribbed plates of cast semi-steel have been developed for highway rail crossings by the Ramapo Ajax Corp., 230 Park Ave., New York City. The plates may be installed in single or multiple track crossings. The installation is made up of approach plates on the outside of the running rails and two center plates between the running rails, the center plates bearing on an added center rail, which may be of any section scrap rail. Signal operations on the railroad is not interfered with, as the plates are fully insulated. The plates rest on insulating shims on the base of the rails and are also fastened to the ties by screw spikes. They are of such weight that any one plate can be handled by two men, and the entire crossing can be set in place by an ordinary construction crew in three or four hours.

Semi-steel plates for highway crossings.



New Equipment in Brief

Bucket Loader Repairs—The Georg Haiss Mfg. Co. is now equipping its Hai excavator and its series of heavy-du loaders with paddles to which can be bolte renewable tips. This new feature elim nates the necessity of replacing the entir manganese steel feeding paddle whe worn, as the inexpensive tips restore th paddle to full length and can be replaced a often as necessary.

Herringbone Gears—Murray Iron Work Co., Burlington, Iowa, announces the de velopment of high-speed herringbone gear suitable for use in connection with gen erators, pumps and fan drive motors, stea turbines or oil engines as drivers. These gears are suitable for speeds from the lowest up to 5,000 r.p.m. and horsepower from 100 to 3,000. They are made in double or single reduction units, with complete lubrication and cooling systems, the gear faces being lubricated by means of oil sprays and the bearings having forced lubrication.

Clay Blocks—The Sayre & Fisher Brick Co., Sayreville, N. J., has developed a clay block as a new load-bearing unit. Tests were made at Rutgers University showing that the compression strength of the clay block is more than 4,000 lb. per sq.in. of gross area. As the base of the block is 66 sq.in., one block, weighing 16 lb., can withstand a load of 264,000 lb. The blocks are of cellular construction, 12 in. long, 5 in. high and 5½ in. wide. They are suitable for foundations, backing walls, building walls, piers and columns and retaining walls.

Tautline Cableway—Sauerman Bros., 438 South Clinton St., Chicago, has added a tautline cableway to its line of cableway excavating equipment. The new cableway is adaptable to either stationary or movable head and tail towers.

New Type Clamshell Bucket—The Wellman Engineering Co., Cleveland, Ohio, which has recently taken over the G. H. Williams Co., of Erie Pa., announces a new Williams Champion cleanup-rehandler clamshell bucket. The new bucket combines the digging power of the standard Williams Champion with the speed and snap of the Williams rehandler and the long reach of the Williams scraper. It has the Williams power arm combination of lever and block and tackle, giving faster rehandling by developing high digging power with minimum cable overhaul. The bucket is available in eight sizes from ¾ to 3 cu.yd.

Timing Control for Welding Service—A new timing device for spot, projection and other forms of resistance welders has been developed by Cutler-Hammer, Inc., 238 North Twelfth St., Milwaukee, Wis. The manufacturer claims extremely accurate timing control of the welding operation. Use of an electronic tube makes possible an accuracy of better than a fraction of a second, and the device has an adjustable range up to 16 seconds. This new tube timing welder control is said to eliminate all guesswork on the operator's part, enabling unskilled operators to produce successful welds and practically to eliminate rejects and throwouts. It requires a very small mounting space and operates on 110 to 550 volts a.c., 25 to 60 cycles.

Steel Tapes—The Lufkin Rule Co., Saginaw, Mich., has introduced two new steel tapes known as the Crescent and Junior Crescent tape-rules. These tape-rules provide the practical combination of the utility of a rule with the accuracy and convenience of a pocket steel tape. Although the tapes automatically wind up in chromium steel cases like the ordinary steel tape, the blades are especially formed to make them stand rigid for straight measuring. They will also conform to curves and irregular shapes. The Crescent Junior comes in 4- and 6-ft. lengths, and the Crescent is a 6-ft. tape of heavier design.

Snow Scraper—The Pneu-Hydro Road Machinery Co., Cadillac, Mich., now has a snow blade attachment for its pneumatic road planer which attaches to the under side of trucks. The blade is made in 8-, 10- and 12-ft. sizes and will handle snow up to 8 and 10 in. deep. It is operated by compressed air.

Electric Erasers—An electric erasing machine so small that it is held between the fingers is now made by the Charles Bruning Co., Inc., 102 Reade St., New York City. The instrument is only 5 in. long and weighs but 14 oz.

New Electrode for Welding Aluminum—The Lincoln Electric Co., Cleveland, Ohio, announces a new electrode for welding aluminum which will be known as "Aluminweld." The new electrode is a 5 per cent silicon aluminum alloy and can be used for welding sheet or cast aluminum. It is designed for either metallic or carbon arc welding. It is provided with a coating which prevents excessive oxidation and will dissolve any aluminum oxide that might be formed.

Welder Tip Adaptor—The Linde Air Products Co., 30 East 42d St., New York, has recently added to its line of Purox welding apparatus the Purox 11-to-00 tip adaptor which can be used to increase the range of usefulness of the Purox No. 11 welding torch. By means of the new tip adaptor it is now possible to use the stems and tips of the Purox No. 00-D aircraft welding torch and the stems and tips of the Purox No. 00 welding and lead burning torch on the Purox No. 11 welding torch, thus enabling a welder who has only an occasional light welding job to use the correct welding tips for this small work.

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Full-Revolving ⅜-Yd. Shovel

A full-revolving convertible shovel, crane and excavator with ⅜-yd. bucket capacity and a crane capacity of 5 tons, with convertibility including clamshell, dragline, skimmer, trench hoe and other attachments, is a new product of Bay City Shovels, Inc., Bay City, Mich. The machine weighs 13½ tons equipped as a shovel. Standard shovel boom length is 15 ft. with an optional 17-ft. boom if desired. The crane boom length is 30 to 35 ft. The machine, known as model B, is identical in pattern and design with the heavy-duty Bay City ¾-yd. and 1-yd. models. It is offered with optional McCormick-Deering or Hercules power. The ⅜-yd. rig is equipped with all the features incorporated into the larger models, including chain crowd, heavy unit cast body, unit cast revolving machinery table, and frictionless bearings.

Convertible shovel and crane of ⅜-yd. capacity.

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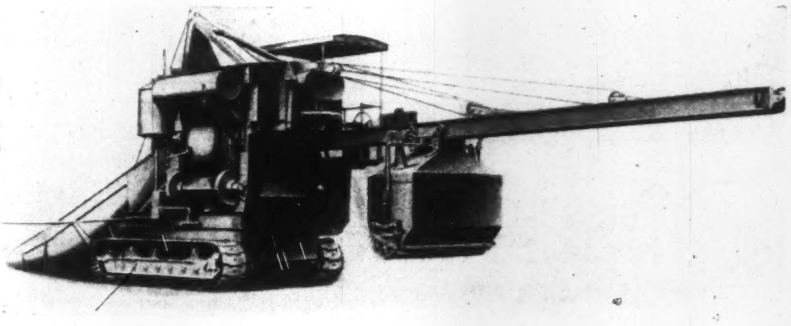
Paver Made Faster and Heavier

The new 1932 Multi-Foote paver, announced by the Foote Co., Inc., Nunda, N. Y., weighs 20 tons, 3 tons of weight having been added due to increased size of parts, resulting in greater rigidity and longer life. The entire paver has been speeded up, starting at the loading skip, which is now raised in 8½ seconds, to the boom bucket, which travels at increased speed. The superstructure has been redesigned with a lowered boom support and a one-man top for loading skip which can be lowered quickly for shipment or to pass under viaducts. Hinged construction in the superstructure eliminates all bolts. The chassis, skip hoist, transmission, boom and bucket have all been enlarged and strengthened

The 1932 Multi-Foote paver.



New Publications

Tractors—Numerous and varied applications of tractors in construction work, agriculture, industrial haulage, road maintenance and snow clearing are shown in 24-p. bulletin 60 of the CATERPILLAR TRACTOR Co., Peoria, Ill.

Asphalt Plants—A new catalog describing two-fire asphalt plants, both portable and stationary, cold-mix asphalt plants, drier-coolers and combination hot and cold mix asphalt plants and mixers has been issued by the F. D. Cummer & Son Co., Keith Bldg., Cleveland, Ohio.

Concrete Curing—Curing of concrete with "Concrete Special" silicate of soda is described in 16-p. bulletin 31 issued by the Philadelphia Quartz Co., Philadelphia.

Gearmotors—Gearmotors, consisting of speed reducers compactly combined with induction motors into general purpose unit drives, are the subject of a new publication, Leaflet 20536, issued by the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Roller Chains—The Jeffrey Manufacturing Co., Columbus, Ohio, describes its complete line of steel thimble roller chains in a new 48-p. catalog No. 525. Complete engineering data on this type of roller chains are given in the catalog.

Promal Metal—The Link Belt Co., Indianapolis, Ind., is distributing a new book, No. 1250, devoted to Promal castings. Promal, a metal originally developed for Link-Belt's own use in manufacture of conveying and power transmitting chains, is now available in casting form. The new booklet shows its various applications and gives comprehensive description of its qualities and technical data concerning it.

Cement-Lined Cast-Iron Pipe—The American Cast Iron Pipe Co., Birmingham, Ala., has issued a 16-p. booklet devoted to the advantages, manufacture and installation of cement-lined cast-iron pipe. The catalog contains a table of adjusted values of the coefficient C applicable to Williams and Hazen's hydraulic tables. The value for C of 145 has been established as conservative for modern cement-lined cast-iron pipe. But since the value of C for this type of pipe has been determined for the actual inside diameter of the lining, allowance must be made for the reduced area before it is applicable to Williams and Hazen's hydraulic tables, which are based on nominal pipe diameters.

Steam Line Equipment—The 1932 catalog of the American District Steam Co., North Tonawanda, N. Y., covers this company's line of specialties and accessories for underground steam and hot water lines.

Street Cleaners—A 10-p. booklet of the Elgin Corp., 501 Fifth Ave., New York, and Chicago, describes in full the model D Elgin motor street sweeper. This machine cleans a path 9 ft. wide at a speed of 7 miles per hour.

Washing Equipment—Bulletin No. 1471 issued by the Allis-Chalmers Mfg. Co., Milwaukee, Wis., describes the full line of stone scrubbers, sand washers, log washers in revolving drums, screw and vibrating screens.

Automatic Pump Control—A 4-p. booklet issued by the Electric Controller & Mfg. Co., 2606 East 79th St., Cleveland, Ohio, describes automatic pumping control equipment and its installation.

Illumination—The General Electric Co., Schenectady, N. Y., has published several pamphlets describing floodlighting for outdoor construction, floodlighting monuments and memorials, floodlighting for estates and homes, illumination of parks and illumination of gun clubs and tennis courts.

Gears and Gear Blanks—Fabroil and Textolite gears and gear blanks are covered in two pamphlets issued by the plastics department of the General Electric Co.

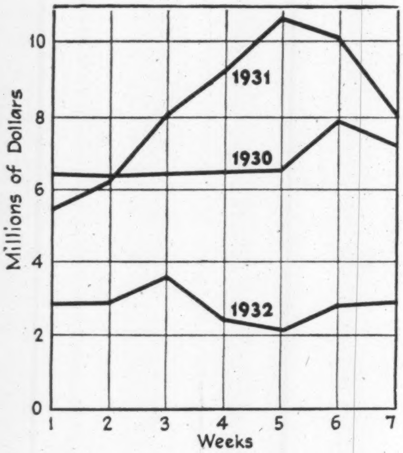
Road Graders—The Austin-Western Road Machinery Co., 400 North Michigan Ave., Chicago, has published new bulletins describing two of its line of road graders. The Austin 101 leaning wheel grader is described in bulletin 1238 and the Austin 77 six-cylinder dual-drive motor grader is covered in bulletin 1239.

Bortz Bits—Bulletin 85-RA, issued by the Sullivan Machinery Co., 400 North Michigan Ave., Chicago, describes the Sullivan "Ready-set" bortz bits for diamond core drills. The bulletin includes the use of small African bortz for setting core drill bits, the development of "round shoulder" bits set with bortz and the Sullivan bortz bits for core drill use.

Business Side of Construction

Contract Letting Shows Drop in First Two Months of 1932

Contracts have been let this year at the rate of $21,000,000, compared with $46,000,000 in the first two months of 1931 and $48,000,000 in the first two months of 1930. The drop is evenly divided between public and private construction. But whereas the value of private contracts was the same in February as in January, $40,000,000, public-works contracts dropped from $51,000,000 in January to $37,000,000 in February, or 27 per cent. This drop included $8,000,000 in federal government contracts in the region between the Mississippi River and the Rocky Mountains. The accompanying chart compares the rate of street and road lettings for the first two months of this year with the rates in 1930 and 1931.



Five weeks' moving average of street and road lettings in two months of 1930-32.

Material Notes

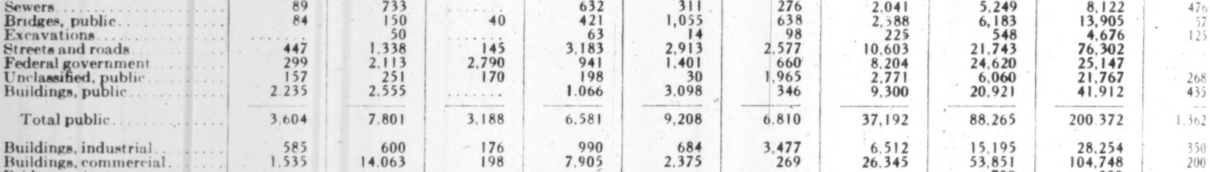
Cement—Indiana state highway
ment, requiring 1,800,000 bbl. or 7,
loads of bulk cement, received a bid
per barrel at mill and 98c. deliv
various highway jobs. A year
delivered price for 1,750,000 bbl. wa
The formal mill base for Indian
is $1.10 per barrel. Manufacturer
Dallas-Fort Worth district have
tinued trucking from mill to job a
sell all cement through authorized
and ship it in freight cars to dealer
tracks or siding. Manufacturers
other districts have abandoned truc
favor of rail shipment: Albany,
Philadelphia, Pittsburgh, Clevelan
Youngstown. During January shi
dropped 19 per cent and producti
lowered 17 per cent; but stocks in
7 per cent.

Steel—Weekly rate for fabricated
tural bookings in February was 4,0
compared with 18,000 tons per we
year ago. Backlog of the Steel C
tion on Feb. 1 was 2,648,150 tons, th
est on record. Mill operating rates
country are 27 per cent of capacity,
is about the average figure since O
One year ago the rate was 52 per

Lumber—Mill prices for the whole

ENGINEERING CONSTRUCTION CONTRACTS REPORTED IN FEBRUARY, 1932
Thousands of Dollars (000 Omitted)

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States			Canada Feb. 1932
							Feb. 1932	Two Months		
								1932	1931	
Waterworks	$293	$611	$43	$77	$386	$250	$1.660	$2,941	$8,541	$1
Sewers	89	733	......	632	311	276	2,041	5,249	8,122	476
Bridges, public	84	150	40	421	1,055	638	2,388	6,183	13,905	57
Excavations	....	50	......	63	14	98	225	548	4,676	125
Streets and roads	447	1,338	145	3,183	2,913	2,577	10,603	21,743	76,302	
Federal government	299	2,113	2,790	941	1,401	660	8,204	24,620	25,147	
Unclassified, public	157	251	170	198	30	1,965	2,771	6,060	21,767	268
Buildings, public	2,235	2,555	....	1,066	3,098	346	9,300	20,921	41,912	435
Total public	3,604	7,801	3,188	6,581	9,208	6,810	37,192	88,265	200,372	1,362
Buildings, industrial	585	600	176	990	684	3,477	6,512	15,195	28,254	350
Buildings, commercial	1,535	14,063	198	7,905	2,375	269	26,345	53,851	104,748	200
Bridges, private	....	....	....	....	....	....	....	700	230	
Unclassified, private	350	5,458	....	150	377	262	6,597	9,504	82,133	50
° Total private	2,470	20,121	374	9,045	3,436	4,008	39,454	79,250	215,365	600
February, 1932, 4 weeks	**6,074**	**27,922**	**3,562**	**15,626**	**12,644**	**10,818**	**76,646**	....	....	**1,962**
January, 1932, 4 weeks	6,082	43,191	5,500	12,843	12,279	10,974	90,869	....	....	9,427
February, 1931, 4 weeks	5,893	59,862	21,583	35,924	38,115	17,165	178,542	....	....	11,091
Two months, 1932	12,156	71,113	9,062	28,469	24,923	21,792	....	167,515	....	11,389
Two months, 1931	19,031	178,224	39,784	69,736	70,815	38,147	....	....	415,737	23,781



Value of contracts awarded—weekly averages.

try averaged $12 per 1,000 ft.b.m.—37 per cent below levels of January, 1931, when the depression was commencing. February shipments declined 1.7 per cent and production was lowered 5.5 per cent; stocks are the same as for January.

Common Brick—Prices dropped $1 in Boston and Minneapolis. Face and paving grades cheaper in Boston. Market generally slow but stocks are lower.

Cast-Iron Pipe—A special freight decrease of 22c. per ton, from 66c. to 44c., on rail movements of cast-iron pipe from Southern plants to the ports of Mobile, Savannah and Norfolk for reshipment to north Atlantic ports, has been suspended until Sept. 8, 1932. Lower prices were reported during the month at Detroit, Minneapolis and San Francisco.

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Labor Notes

Hartford—Wage reductions of 25 per cent effective March 1 in several skilled trades of northern Connecticut. Carpenters will receive $7.50, masons and ironworkers $9, and pile setters $5.

Boston—Builders will try again to obtain signed agreement with union for a reduced wage. Carpenters have already accepted a cut of 14½c.

Rochester—Laborers on Monroe County highway construction reduced 15c. per hour, to 25c., on Feb. 23; 850 additional men will be employed.

Albany—Unions reject builders' proposal of scale reductions averaging 20 per cent and builders reject unions' offer to arbitrate. Masons' union will accept cut of $2 per day, to $12, but has not agreed to builders' proposal of a $4 cut.

Elizabeth, N. J.—Laborers' local No. 394 fined twelve members $50 each for alleged acceptance of wages below minimum scale.

Trenton—Carpenters' and joiners' brotherhood petitioned the governor to close state vocational schools.

Pittsburgh—Negotiations on between employers and unions toward signing agreement on proposed 25 per cent reduction. Carpenters agree to cut of $2 per day, to $10, on assurance that master builders will not sublet carpentry work.

Baltimore—Official scale effective Feb. 25 cuts bricklayers 25c. per hour, to $1.25; carpenters 10c., to 90c.

Washington—Employers propose wage cuts of $1 per day for masons' laborers to $5; $3, to $10 per day, for metal lathers; $4, to $10, for plasterers and cement finishers.

Louisville—Sewerage commission excludes all non-citizen common labor on local projects; residence must be for one year.

Columbus, Ohio—Minimum of 40c. per hour adopted for state, county and city unemployment relief program for highway workers.

St. Louis—Temporary wage reduction of 33⅓ per cent effective April 1.

Minneapolis—New building trade scale ratified Feb. 4 at rates actually being paid to majority of skilled crafts. Northwestern Bell Telephone Co. has advanced $110,000 worth of its 1933 construction program to give employment this year.

Chicago—Agreement signed Feb. 12 by 31 trades totaling 150,000 men for reductions averaging 20 per cent. Employers had asked 25 per cent. Agreement expires March 1, 1933. The new rates for the principal trades are shown in the accompanying monthly table.

Indiana—State highway program for remainder of year provides employment for additional 5,000 men on maintenance and 5,000 on paving.

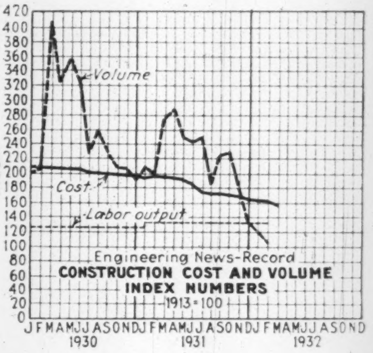
Davenport—Sheet metal workers accept cut of 50c. per hour, to $1, to extend to Feb. 1, 1933.

Rock Island—Minimum wage of 40c. declared on county road projects, against 25c. to 30c. hitherto prevailing.

Average Wages—Average skilled wage for construction is $1.08 per hour as in February, compared with $1.36 in March, 1931. Common labor average is 43.58c., compared with 44.21c. in February and 53.71c. in March, 1931.

Construction Cost and Volume Index Numbers

The March Cost Index (157.24) is 3 per cent under that for February and is 19.4 per cent below that of March, 1931. It is, moreover, the lowest number for any month since December, 1916, at which time the Cost Index stood at 149.41. The February Volume Index (105) is 13.2 per cent smaller than that of January and 46.9 per cent smaller than that for February, 1931. The February volume is the smallest for any month, since August, 1923, at which time the Volume Index touched 100.



E.N.-R. Cost		**E.N.-R. Volume**	
March, 1932	**157.24**	**Feb., 1932**	**105**
Feb., 1932	161.82	Jan., 1932	121
March, 1931	194.51	Feb., 1931	198
1931 (Average)	181.35	1931 (Average)	220
1930 (Average)	202.85	1930 (Average)	260
1913 average	100.00		
1931		1931	
January	194.48	January	208
February	196.61	February	198
March	194.51	March	278
April	191.63	April	289
May	189.33	May	251
June	187.23	June	243
July	174.37	July	248
August	171.38	August	187
September	171.40	September	225
October	169.78	October	229
November	169.28	November	180
December	166.23	December	133
1932		1932	
January	162.48	January	121
February	161.82	February	105
March	157.24		

CURRENT BUILDING AND CONSTRUCTION TRADES WAGE RATES PER HOUR

Advances since last month are indicated by **heavy type,** declines by *italics*

Cities	Bricklayers	Carpenters	Hoisting Engineers	Pile Drivers	Structural Iron Workers	Masons' Laborers	Common Laborers
Atlanta	*$0.60*	*$0.40*	*$0.50*	....	*$0.50*	*$0.25@0.50*	$020@.35
Baltimore	*1.25*	*.80*@.90	1.00@1.37½	$0.65	1.00@1.25	*.65*	.30
Birmingham	.75@.87½	.60	.60@.90	....	.60@.90	.30@.40	*.15*@.25
Boston	1.50	1.17½	1.37½	1.27½	1.37½	.85	.40@.80
Cincinnati	1.25@1.62½	1.00@1.40	1.00@1.40	1.00	1.00@1.40	1.00	.40@.45
Chicago	*1.36*	*1.30*	*1.30*	*1.30*	*1.34*	*.78*	.50@*.78*
Cleveland	.90@1.37½	.75@1.12½	1.00	1.10	.90@1.00	.50@.62½	*.30@.40*
Dallas	1.00@1.12½	.65@.87½	.75@1.00	.75@1.00	1.00	.35@.50	.20 @.25
Denver	1.00@1.12½	.75@.87½	.75@.87½	....	.75@.87½	.50	.31¼@.50
Detroit	1.00@1.25	.60@.80	1.00@1.10	1.00@1.10	1.00@1.25	.50	.30 @.50
Kansas City	1.62½	1.32½	1.37½	1.32½	1.32½	.82½	.25@.75
Los Angeles	*.87½*	.75	1.00	1.00	.87½@1.00	*.50*	.50
Minneapolis	1.10	.75@.85	.80	....	.90	.70	.45
New Orleans	.60@.80	.40@.50	1.12½	.90	.80@1.12½	.50	.15@.20
New York	1.50@1.92½	1.25@1.65	1.92½	**1.78¾**	1.92½	.81¼@1.23¾	.50@.81¼
Philadelphia	1.50	.90@1.00	1.02½@1.36	1.00	1.37½	.40	.40
Pittsburgh	.70@1.75	.70@1.50	.70@1.50	....	.70@1.50	.50	.50
St. **Louis**	1.75	1.50	1.60@1.75	1.25	1.75	*.81¼*	.35@*.81¼*
San **Francisco**	1.37½	1.12½	1.12½	1.12½	1.37½	.87½	*.40*@.68¾
Seattle	.87½@1.50	.62½@1.12½	1.12½@1.25	1.12½@1.25	1.12½@1.25	.70	*.40*@.70
Average	*1.19¾*	*.93¾*	*1.12*	*1.10⅞*	*1.10¾*	*.62½*	0.4358
Montreal	1.12½	.75	.70	*.70*	.75	.40	.25@.40

◆

Capital and Contracts

New capital issued in the week ended Feb. 27 amounted to $14,000,000, compared with $25,000,000 in the preceding week. Private financing dropped from $25,000,000 to $2,000,000, while public issues, of which there was none in the week ended Feb. 20, reached $12,000,000 for the week of Feb. 27.

Cumulatively, the total for the period Jan. 1 to Feb. 27, 1932, inclusive, is $93,000,000, against $618,000,000 in the corresponding period of 1931.

This week's contracts with comparisons, are as follows:

(In Thousands of Dollars)

	Mar. 3, 1932	Average of Last Four Weeks 1932	1931
Buildings:			
Industrial	$1,000	$852	$4,786
Other	3,128	5,811	14,684
Streets and roads	2,285	2,983	10,368
Other construction	4,288	5,895	12,152
Total	$10,702	$15,541	$41,991
Total, all classes, Jan. 1 to Mar. 3:			
1932			$178,217
1931			463,261

Current Prices of Construction Materials

Price advances since last month are indicated by **heavy type**; declines by *italics*

Building Materials

PORTLAND CEMENT—Prices per barrel, for cement in cloth, *without including charge for four bags at 10c. each.* Cash discount not deducted. Prices are for carloads of 132 barrels or over, delivered to contractor at site of job:

	Mar. 3, 1932	One Mo. Ago	One Yr. Ago
Atlanta	*$1.95*	$2.25	$2.60
Baltimore	1.87	1.87	2.60
Birmingham	*1.95*	2.40	2.60
Boston	*1.86*	2.00	2.30
Chicago	1.55	1.55	2.10
Cincinnati	1.60	1.60	2.26
Cleveland	1.25	1.25	2.00
Dallas	1.88	1.88	2.15
Denver	*1.95*	2.40	2.20
Detroit	*1.85*	1.90	2.05
Jersey City	1.79	1.79	2.33
Kansas City	*1.90*	2.00	2.50
Los Angeles	*1.95*	2.30	1.92
Minneapolis	*1.95*	2.10	2.50
Montreal	*1.95*	2.18	2.20
New Orleans	*1.90*	2.01	2.35
New York	1.60	1.60	2.10
Philadelphia	1.95	1.95	2.15
Pittsburgh	*1.78*	1.81	2.15
St. Louis	1.85	1.85	2.15
San Francisco	*1.95*	2.44	2.64
Seattle	*1.95*	2.20	2.25

Current mill-prices per barrel to dealers, for carloads of 132 barrels or over, without including charge for four cloth bags, f.o.b.:

Alpena, Mich	$1.20	Mason City, Ia	$1.10
Buffington, Ind	1.10	Norfolk, Va	1.61
Dallas, Tex	1.74	Northampton, Pa	1.21
Hannibal, Mo	1.10	North Birmingham, Ala	1.31
Hudson, N. Y	1.21	Richard City, Tenn	1.31
Independence, Kan	1.10	Steelton, Minn	1.61
Ironton, Ohio	1.06	Universal, Pa	1.21
Iola, Kan	1.10	Waco, Tex	1.65
La Salle, Ill	1.10	Wyandotte, Mich	1.20
Limedale, Ind	1.10		

SAND AND GRAVEL—Per ton, delivered. Gravel, sizes ¾-in. or 1½-in.:

	Gravel	Sand
Atlanta	$2.50	$2.25
Baltimore	2.45	2.08
Birmingham, per cu.yd., 2,600@2,800 lb	2.75	2.25
Boston	1.58	1.10
Chicago, per cu.yd., 3,000 lb	1.65	1.65
Cincinnati	1.50	1.25
Cleveland, per cu.yd., 3,000 lb	2.00	2.00
Dallas, per cu.yd., 2,750 lb	2.25	2.25
Denver, per cu.yd., 2,700 lb	1.80	1.35
Detroit	1.65	1.50
Kansas City	2.00	2.00
Los Angeles	2.20	1.60
Minneapolis, per cu.yd., 2,800 lb	2.05	1.00
Montreal	1.50	1.25
New Orleans, per cu.yd., 2,700 lb	2.02½	1.28
New York, per cu.yd., 2,800@3,000 lb	2.75	1.75
Philadelphia	2.78	1.98
Pittsburgh	1.55	1.75
St. Louis	1.65	1.35
San Francisco	1.75	1.75
Seattle, per cu.yd., 2,900@3,000 lb	1.85	1.85

CRUSHED STONE—Per ton, size 1½-in., limestone, delivered:

Atlanta	*$2.75*
Baltimore	2.60
Birmingham	*Slag used*
Boston	1.88
Chicago, per cu.yd., 2,500 lb	1.65
Cincinnati	2.25
Cleveland	2.50
Dallas, per cu.yd., 2,500 lb	*2.90*
Denver, granite, per cu.yd., 2,700 lb	2.50
Detroit	1.95
Kansas City	2.00
Los Angeles	2.20
Minneapolis, per cu.yd., 2,600 lb	2.40
Montreal	*1.80*
New York, per cu.yd., 2,800@3000 lb	2.75
Philadelphia	2.73
Pittsburgh	*3.00*
St. Louis	1.65
San Francisco, trap rock	1.65
Seattle, per cuyd., 3,000 lb	3.00

CRUSHED SLAG—Prices for carloads, per net ton, at plant:

	1½-In.	¾-In.	Roofing	Sand
Birmingham, Ala	$0.90	$1.15	$2.05	$0.55
Buffalo District	1.25	1.35	2.25	1.25
Cleveland, Ohio	1.10	1.10	2.25	.70
Western Pennsylvania	1.25	1.25	2.00	1.25
Toledo, Ohio	1.10	1.10	1.10	1.00
Youngstown District	1.25	1.35	2.00	1.25

CONCRETE BLOCKS—Standard, 8x8x16-in., hollow, delivered to job, each:

Birmingham (5x8x12)	$0.084	Kansas City	$0.18
Boston	.18	Minneapolis	.10
Brooklyn and Queens	.12	New Orleans	.18
Chicago	.23	Philadelphia	.215
Cleveland	.165	Pittsburgh	23
Denver	.22	St. Louis	.14
Detroit	.12		

HOLLOW TILE—Building tile per block, delivered to contractors in lots 2.000 pieces or over:

	4x12x12	6x12x12	8x12x12	10x12x12	12x12x
Atlanta	$0.09	$0.11	$0.13	$0.20	$0.25
Baltimore	.105	.14	.20	.23	.30
Birmingham	.089	.122	.167	.219	.25
Boston	.08	.115	*.145*	.21	.32
Chicago	.048	.066	.09	.117	.13
Cincinnati	.06815	.09485	.129	.165	.184
Cleveland	.048	.066	.09	.117	.13
Dallas	.091	.121	.159	.19	.23
Denver	.0975	.135	.175	.2125	.25
Detroit	.08	.11	.145	.19	.21
Kansas City	.088	.11	.145	.19	.21
Los Angeles	.09425	.134	.188	.2325	.311
Minneapolis	.0787	.1034	.1343	.1643	.228
New Orleans	.085	.115	.16	.225	.255
New York	.075	.125	.14	......	......
Perth Amboy, N. J. (f.o.b.)	......	......	......	.2388	.2956
Philadelphia	.105	.14	.215	.28	.34
Pittsburgh	**.0458**	**.065**	**.088**	**.113**	**.126**
St. Louis	.068	.098	.12	.16	.20
San Francisco	.0765	.105	.1765	......	......
Seattle	.085	.115	.18	......	......

BRICK—Prices delivered per thousand are as follows:

	Common	Face	Paving F.O.B. 3x8½x4-in.	Paving F.O.B. 3½x8½x4-in.
Atlanta	$14.00	$20.50	$32.00	$37.00
Baltimore	12.50	30.00	40.00	43.00
Birmingham	13.50	22.50	27.00	32.00
Boston	*13.00*	*27.50*	*47.00*	*52.00*
Chicago	12.00	32.50	32.00	38.00
Cincinnati	16.00	24.00	35.00	37.00
Cleveland	13.00	24.50	33.00	36.00
Dallas	13.50	21.00	......	35.00
Denver	9.50	25.00	......	......
Detroit	15.00	25.00	25.00	35.00
Kansas City	14.00	20.00	35.00	37.50
Los Angeles	**9.00**	26.50	......	......
Minneapolis	*8.50*	30.00	......	......
Montreal	28.00	......	......	......
New Orleans	12.50	......	40.00	45.00
New York	11.50	30.00	45.00	50.00
Philadelphia	16.00	......	40.00	45.00
Pittsburgh	12.00	22.00	*25.00*	*25.00*
St. Louis	14.00	22.00	35.00	35.00
San Francisco	14.00	......	45.00*	......
Seattle	14.00	......	48.50	61.00

*2½x8½x4-in.

LIME—Prices delivered to job:

	Hydrated, Per Ton Finishing	Hydrated, Per Ton Common	Lump, Per Barrel Finishing	Lump, Per Barrel Common
Atlanta	$13.50	$11.50	......	$2.50†
Baltimore	22.00	14.00	......	2.25†
Birmingham	30.00	17.50	......	2.00†
Boston	*21.00*	*14.00*	$4.00*	3.10*
Chicago	13.00	12.00	1.50†	1.25†
Cincinnati	13.05	10.70	......	......
Cleveland	12.00	10.00	2.50†	2.50†
Dallas	20.00	......	2.40†	......
Denver	30.00	23.75	3.80*	3.00*
Detroit	13.00	12.00	1.65†	1.55†
Kansas City	19.00	18.00	2.25†	2.00†
Los Angeles	26.00	18.00	2.00†	2.00†
Minneapolis	25.50	21.00	......	1.70†
Montreal	18.00	10.00	......	......
New Orleans	22.00	13.00	2.10†	1.95†
New York	16.00	13.00	4.10*	3.15*
Philadelphia	18.00	14.50	18.00‡	14.00‡
Pittsburgh	**15.00**	**14.00**	4.25*	2.75†
St. Louis	18.00	16.00	......	12.50‡
San Francisco	17.50	17.50	......	1.59†
Seattle, paper sacks	35.00	24.00	......	2.80†

*Per 280-lb. bbl. (net). †Per 180-lb. (net). ‡Per ton.

LIMESTONE—Mill blocks, f.o.b. siding, per cu.ft.:

New York: Rustic buff, $1.37; Standard gray, $1.47; Standard, $1.57; Selected gray, $1.57; Selected buff, $1.67.

Boston: Rustic buff, *$1.43*; Standard, *$1.56*; Selected buff, *$1.70*.

Pittsburgh: Rustic buff, **$1.56**; Standard, **$1.76**; Selected buff, **$1.86**.

SLATE—Roofing, f.o.b. quarry, Bangor, Pa., net, per square;

No. 1 Clear	*$8.25@$9.50*
No. 1 Ribbon	*6.75@ 7.50*
Medium Clear	*7.25@ 8.00*

Road and Paving Materials

PAVING STONE—Granite, lots of 50,000 blocks, 4x8x4-in., dressed, f.o.b. city:

Atlanta	$3.00 per sq.yd.
Baltimore	3.00 per sq.yd.
Birmingham	76.25 per M.
Boston	105.00 per M.
Chicago, 5 in	3.80 per sq.yd.
Cincinnati	110.00 per M.
Cleveland	95.00 per M.
Detroit, 5 in	3.00 per sq.yd.
Kansas City	2.75 per sq.yd.
Minneapolis, 4½ in	2.80 per sq.yd.
Montreal	104.75 per M.
New Orleans	2.80 per sq.yd.
New York, 5 in	120.00 per M.
Philadelphia	105.00 per M.
St. Louis, 5 in	3.00 per sq.yd.

Current Prices of Construction Materials

Road and Paving Materials—Continued

WOOD-BLOCK PAVING—Prices, f.o.b., in carloads:

	Size of Block	Treatment	Per Sq.Yd.
Atlanta	3½	16	$2.25
Boston	3½	16	2.25
Chicago	3½	12	1.90
Kansas City	3½	16	2.00
Minneapolis	3½	16	2.50
Montreal	3½	16	2.63
New Orleans	3½	16	2.30
New York	3½	14	1.90
St. Louis	3½	16	2.10

FLAGGING—Alongside dock, New York, per sq.ft.:
Manhattan and Bronx, 4 ft. wide....$0.24 Queens, 5 ft. wide....... $0.26

CURBING—Prices per lin.ft., f.o.b., cutting charges not included:
New York: Bluestone, f.o.b. barge, straight, 5x16-in., rough, *.80* @85c.
Birmingham: Granite, straight, 5x16-in., 50c.; 6x20-in., 60c.; roundings, 5x16-in., 65c.; 6x20-in., 80c.
St. Louis: Class "B" straight, 5x16-in., *75c.*; roundings, *$1.00*.
Pittsburgh: Sandstone, 6x24-in., 80c.

ASPHALT—Paving asphalt, f.o.b., per ton. Packages are 350-lb. bbl. or 425-lb. drums, in carload lots:

	Packages	Tank-car or -boat
Atlanta	$18.60	$14.60
Baltimore (f.o.b. refinery)	16.00	12.00
Birmingham (f.o.b. refinery)	.....	12.00
Boston	*21.00*	*17.00*
Chicago	22.50	15.50
Cincinnati	.....	12.00
Cleveland	18.25	14.50
Dallas	*19.50*	.....
Denver	27.50	.....
Detroit	16.68	12.43
Kansas City (f.o.b. refinery)	16.00	11.00
Los Angeles (f.o.b. refinery)	18.00	12.00
Maurer, N. J. (Bermudez)	......	25.00
Maurer, N. J. (Trinidad)	......	21.00
Minneapolis (f.o.b. Twin Cities)	23.30	18.10
Montreal	17.00	13.00
New Orleans (f.o.b. refinery)	16.00	12.00
New York (f.o.b. refinery)	16.00	12.00
Philadelphia	16.00	12.00
Pittsburgh	25.00	16.00
St. Louis	*18.60*	*14.60*
San Francisco (f.o.b. refinery)	18.00	12.00
Seattle	21.40	18.00

LIQUID ASPHALT—Residual, prices f.o.b., in tank cars, 8,000 gal. minimum, 45% asphalt, per gal.:

New York	$0.05
Birmingham	.06
St. Louis	.04
Dallas	.05

Iron and Steel

PIG IRON—Furnace, No. 2 foundry, per gross ton:

	Current	Mo. Ago	Yr. Ago
Birmingham	$10.00@$12.00	$11.00	$14.00
Buffalo	15.00@ 16.00	15.00	17.50

STRUCTURAL STEEL—Prices per 100 lb., delivered from warehouse except in Birmingham and Pittsburgh, where prices are f.o.b. mill. Beams and channels, 3 to 15 in; angles 3 to6-in., ¼-in. thick; tees, 3-in. and larger; and plates, ¼-in. thick and heavier:

Birmingham	$1.65	New York	$2.35
Chicago	3.00	Pittsburgh	1.50
Cleveland	2.95	St. Louis	3.25
Dallas	3.25	San Francisco	2.90

BARS, CONCRETE REINFORCING—Prices per 100 lb., delivered from warehouse except in Birmingham and Pittsburgh, where prices are f.o.b. mill, on bars rolled from billets, size ¾-in.:

Birmingham	*$1.65*	New York	$2.35
Chicago	1.65	Pittsburgh	1.50
Cleveland	1.75	St. Louis	3.00
Dallas	2.75	San Francisco	2.50

EXPANDED METAL LATH—Per 100 sq.yd., painted, delivered to job:

Lb. Per Sq.Yd.	New York	Birmingham	Chicago	St. Louis	Dallas	San Francisco
2.2	$11.00	$17.50	$10.60	$16.00	$14.50	$21.50
2.5	12.00	18.50	11.40	17.00	16.50	22.50
3.0	13.00	20.50	12.65	18.50	.....	25.00
3.4	14.00	22.00	13.65	19.25	20.00	27.00

TRIANGLE MESH—Plain, per 100 sq.ft., 4 in. x 4 in. Manufacturers' quotations are in carloads at mills; dealers' are delivered in lots of 10,000 sq.ft. or over:

				Del. From Warehouse			
Style Number	Weight in Pounds Per 100 Sq.Ft.	Pittsburgh Mill	Chicago District Mill	New York	St. Louis	Dallas	San Francisco
032	22	$0.94	$0.96	$1.20	$1.30	$1.31	$1.22
049	28	1.19	1.22	1.51	1.70	1.60	1.55
068	35	1.45	1.49	1.85	2.10	1.80	1.91
093	45	1.87	1.91	2.36	2.65	2.30	2.46
126	57	2.31	2.37	2.92	3.30	2.82	3.03
153	68	2.75	2.82	3.47	3.95	3.36	.....
180	78	3.16	3.24	3.97	....	3.85	.....

STEEL SHEETS—Prices per 100 lb. for base sizes, delivered from warehouse, except in Pittsburgh, where prices are f.o.b. mill:

	Hot-rolled No. 10	Hot-rolled No. 24	Galvanized No. 24
Chicago	$3.20	$3.55	$4.10
Cleveland	3.00	3.60	3.75
New York	2.65	3.50	4.00
Pittsburgh	1.75	2.15	2.80
St. Louis	3.45	3.80	4.35
San Francisco	3.65	4.15	4.65

WIRE ROPE—Discounts from manufacturers' list prices on regular grades of bright and galvanized, Eastern Territory, New York, and East of Missouri River:

	Base
Cast steel round strand rope	[illegible]
Galvanized iron rigging and guy rope (add to list)	[illegible]
Galvanized steel rigging and guy rope	[illegible]
Plow steel round strand rope	[illegible]
Flattened strand rope	[illegible]
"Special Steel" and extra strong cast steel, round strand rope	[illegible]

Discount 5 points less than discount for Eastern territory: California, Colorado, Kansas, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, Texas, Washington and Wyoming. Discount 10 points less than discount for Eastern territory: Arizona, Idaho, Montana and Utah.

RIVETS—Structural rivets, round head, ½-in., full kegs, per 100 lb., delivered from warehouse, except in Pittsburgh, where prices are f.o.b. mill:

Chicago	$3.75
Dallas	4.50
Denver	4.65
New York	4.00
Pittsburgh	2.25
St. Louis	4.00
San Francisco	4.75
Seattle	4.50

STEEL SHEETPILING—Base price, f.o.b., Pittsburgh, for large mill lots, per 100 lb. $1.90

TERNE PLATE—I C, 8-lb. coating, 20x28-in., f.o.b., Pittsburgh mill:
Per package $9.50

SHIP SPIKES—Per 100 lb., black, from warehouse stocks; galvanized are about $1.75 per 100 lb. higher:

	¼-In.	⅜-In.	½-In.
San Francisco	$5.50	$5.05	$4.90
Seattle	7.75	5.65	5.50

Pittsburgh mill base in lots of 200 kegs or more, $2.90 per 100 lb.

WIRE NAILS—Per 100 lb. keg, base, delivered from warehouse stocks; also Pittsburgh mill base:

Pittsburgh	Birmingham	Chicago	St. Louis	Dallas	San Francisco	Montreal
$1.95	$2.40	$3.30	$2.40	*$3.10*	$2.75	$4.95

SCRAP—The prices following are f.o.b., per gross ton, paid by dealers:

	New York	Chicago	Detroit
No. 1 railroad wrought	$5.00	$6.50*	....
Stove plate	*3.00*	6.25*	$4.50
No. 1 machinery cast	8.50†	8.50*	*8.25**
Machine shop turnings	1.00	4.00	*3.75*
Cast borings	1.00	3.50	*4.25*
Railroad malleable	6.00	7.00	....
Re-rolling rails	6.00	10.50	*8.75*
Heavy melting steel, No. 1	4.25	7.50	7.00
Iron and steel pipe	5.00	4.50	.....

*Net ton. †Delivered direct to foundries.

FREIGHT RATES—The following freight rates per 100 lb., effective Dec. 3 1931, apply on finished steel products in the Pittsburgh district, including plates, structural shapes, merchant-steel bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc.:

Atlanta	$0.60*	Detroit	$0.285†
Baltimore	.29†	Kansas City	.59†
Birmingham	.60*	New Orleans	.69*
Boston	.42†	New York	.35*
Buffalo	.255†	Pacific Coast (all rail)	1.17‡
Chicago	.36†	Philadelphia	.31†
Cincinnati	.285†	St. Louis	.41†
Cleveland	.205†	St. Paul	.60†
Denver	1.17‡		

*36,000 lb. †40,000 lb. ‡60,000 lb.

Railway Materials and Supplies

STEEL RAILS—Standard rails have been $43.00 per gross ton since Sept., 1922 at which time the price was $40.00; other rails, per gross ton, f.o.b., as follows:

	Pittsburgh	Birmingham	Chicago
Light rails	$34.00	$33.00	$34.00
Re-rolled rails	26.00	26.00	32.00

RAILWAY TIES—Prices f.o.b., per tie, for carload lots:

		6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft.
New York	Long-leaf sap pine, untreated	$0.90	$1.10
	Dense yellow pine, untreated	.70	.90
Birmingham	White oak, untreated	.90	1.05
	White oak, creosoted	1.45	1.55
	Southern pine, untreated	.45	.95
	Southern pine, creosoted	1.05	1.40
Chicago	White oak, untreated	1.05	1.35
	Oak, empty cell, creosoted	1.40	1.80
	Oak, zinc treated	1.25	1.65
	Southern pine, creosoted	1.15	1.50
St. Louis	White oak, untreated	.80	1.30
	Red oak, untreated	.75	1.20
	Red oak, creosoted	1.10	1.85
	Sap pine or cypress, untreated	.65	1.10
San Francisco	Douglas fir, green, untreated	.49	.67
	Douglas fir, empty cell, creosoted	1.22	1.64
Montreal	Birch or maple, untreated	1.00	1.00
	Birch or maple, creosoted	1.25	1.55

Current Prices of Construction Materials

Railway Supplies—Continued

TRACK SUPPLIES—Prices per 100 lb., f.o.b., for large mill lots at Pittsburgh and Birmingham, together with warehouse prices at other places named:

	Pittsburgh	Birmingham	Chicago	St. Louis	San Francisco
Standard spikes, 9/16-in. and larger	*$2.60*	$2.70	$3.45	$3.65	$4.10
Track bolts	*3.50*	3.70	4.30	4.50	5.10
Standard section angle bars, splice bars or fish plates	2.75	3.00*	5.75	.....	.....
Tie plates	*1.85*	2.07½	1.95†	.....	.....

*At warehouse. †At mill.

Pipe

WROUGHT STEEL PIPE—Discounts from standard lists for delivery from warehouse, except at Pittsburgh, where prices are f.o.b. mill. List prices per ft. as follows: 1-in., 17c; 3-in., 76½c; 3½-in., 92c; 6-in., $1.92.

	1 to 3-In. Butt Weld		3½ to 6-In. Lap Weld	
	Black	Galvanized	Black	Galvanized
Chicago	57.25%	44.71%	53.83%	41.29%
Cleveland	53.3%	42.3%	50.8%	37.8%
New York	56.14%	43.6%	52.72%	40.18%
Pittsburgh	64%	52.5%	61%	49.5%
St. Louis	51%	38%	48%	35%

CAST-IRON PIPE—Prices per net ton, for bell and spigot pipe, Class B and heavier, f.o.b., on regular lots (250 tons and under) of pipe:

	4-In.	6-In. and Over
Birmingham mill	$35.00@$36.00	$32.00@$33.00
Burlington (N. J.) mill	35.00@ 36.00	32.00@ 33.00
Chicago	43.00@ 44.00	40.00@ 41.00
New York	38.00	35.00
Pittsburgh	43.50@ 44.50	40.50@ 41.50
St. Louis	42.80	39.80
San Francisco	43.00@ 44.00	40.00@ 41.00

Gas pipe and Class A, $3.00 per ton extra.

SEWER PIPE—Prices delivered, per foot, for standard pipe; 6, 8 and 12-in. are single strength and 18, 24, 30 and 36-in. are double strength:

	6-In.	8-In.	12-In.	18-In.	24-In.	30-In.	36-In.
Atlanta	$0.125	$0.21	$0.385	.....	$1.40	.....	.....
Baltimore	.10	.30	.58	.....	1.93	.....	$6.50
Birmingham	.18	.30	.54	$1.02	1.95	$3.50	5.00
Boston	.18	.28	.55	1.35	2.375	3.95	5.90
Chicago	.18	.28	.54	1.25	2.25	4.75	6.00
Cincinnati	.135	.21	.405	1.05	1.89	3.456	5.4325
Cleveland	.1125	.175	.3375	.825	1.485	4.824	7.38
Dallas	.23	.325	.586	1.106	1.95	3.68	5.00
Denver	.161	.23	.414	.816	1.44	.....	.....
Detroit	*.135*	*.21*	*.405*	*1.05*	*2.25*	*4.10*	.....
Kansas City	.21	.335	.52	1.00	1.90	3.60	.....
Los Angeles	.217	.2825	.4985	1.1865	2.034	3.93	.....
Minneapolis	**.18**	*.23*	*.46*	**1.20**	**1.88**	*3.20*	*4.26*
Montreal	.30	.45	.75	1.95	2.60	.....	7.20
New Orleans	**.18**	**.30**	**.54**	**1.02**	**1.95**	.....	.....
New York	.17	.265	.52	1.30	2.34	4.47	6.86
Philadelphia	.0945	.147	.297	.80	1.44	2.304	3.28
Pittsburgh	*.09*	*.18*	*.27*	*.62*	*1.22*	*2.45*	*3.68*
St. Louis	.1295	.235	.423	1.05	1.80	3.20	4.40
San Francisco	*.175*	*.25*	*.45*	*1.05*	*1.80*	*3.00*	*4.50*
Seattle	.22	.30	.54	1.26	2.16	2.50	5.50

CLAY DRAIN TILE—Prices delivered per 1,000 lin.-ft.:

Size, In.	New York	Birm'ham	Pittsburgh	Chicago	St. Louis	San Fran.	Seattle
4	$42.00*	$50.00	$80.00	$40.00	$50.00	$67.50	$69.00
6	75.00*	85.00	110.00	100.00	85.00	112.50	112.00

*F.o.b. in full carload quantities.

Miscellaneous

LINSEED OIL—Raw oil, f.o.b., in 1- to 4-bbl. lots, per lb.:

New York	*$0.07¼*	Minneapolis	$0.083

WHITE AND RED LEAD—Base price per 100-lb. keg, f.o.b., New York: White, dry, $12.00; White, in oil, $12.00; Red, dry, $12.00; Red, in oil, $13.50.

CHEMICALS—Water, sewage treatment, road work, f.o.b., carlots, New York:

Bleaching powder, in drums, f.o.b. works, per 100 lb.	$1.75
Calcium chloride, flaked, in drums, f.o.b. works, per ton	2[illegible].00
Chlorine, cylinders, per lb	.04
Silicate of soda, in drums, f.o.b. works, per 100 lb.	1.35
Soda ash, 58%, in bags, per 100 lb.	1.15@1.17½
Sulphate of aluminum, in bags, per 100 lb	1.25
Sulphate of copper, in bbl., per 100 lb.	3.10

MANILA ROPE—The number of feet per pound for the various sizes is as follows: *¾-in.*, 6-ft., 1-in.; *⅞-in.*, 4-ft., 5-in.; *1-in.*, 3-ft., 8-in.; *1¼-in.*, 2-ft., 5-in.; *1½-in.*, 1-ft., 8-in. Following prices are per lb. for ¾-in. and larger:

Atlanta	*$0.18*	Kansas City	$0.23
Baltimore	.225	Los Angeles	175
Birmingham	.25	Minneapolis	.18
Boston	.20	Montreal	.185
Chicago	.175	New Orleans	.19
Cincinnati	.21	New York	.17
Cleveland	.21	Philadelphia	.21
Dallas	.22	St. Louis	.175
Denver	.20	San Francisco	.175
Detroit	.185	Seattle	.175

BUILDING PAPER—Black, 50-lb. per roll of 500 sq.ft., in carloads, f.o.b., producing point *$2.05*

SLATERS FELT—In carloads, per roll, f.o.b., producing point *$0.65*

PREPARED ROOFING—Prices, delivered to contractors, in carloads, f.o.b New York, per square:

Single shingles, slate finish, sufficient to cover 100 sq.ft.	$6.50
Strip shingles, 4 in 1, hexagonal shape, with Underwriters' label	6.25
Slate surfaced roofing in rolls weighing 85 to 90 lbs.	2.50

ROOFING MATERIALS—Prices, f.o.b. New York, delivered to contract in carloads:

Asphalt felt, per 100 lb.	$2.
Tar felt, per 100 lb.	2.
Asphalt coating, per gal.	
Tar pitch, in 350 lb. barrels, per ton	28.

WINDOW GLASS—Discounts from latest jobbers' window-glass list, da Sept. 15, 1928, at New York warehouse:

	Single Thickness		Double Thickness	
	A Quality	B Quality	A Quality	B Quality
First 3 brackets	89%	91%	88%	90%
Larger sizes	88%	90%	88%	90%

EXPLOSIVES—Price per pound for dynamite delivered:

	Gelatin 40%	Gelatin 60%		Gelatin 40%	Gelatin 60%
Atlanta	*$0.215*	*$0.2375*	Los Angeles	$0.1725	$0.192
Baltimore	.215	.2375	Minneapolis	.18	*.19*
Birmingham	.135	.1575	Montreal	.17	.195
Boston	.225	.25	New Orleans	.195	.22
Chicago	.17	.195	New York	.245	.267
Cincinnati	.22	.245	Philadelphia	.215	.24
Dallas	.185	.21	St. Louis	.1975	.217
Denver	.19	.2125	San Francisco	.155	.18
Kansas City, Mo.	.2025	.2225	Seattle	.1525	.175

Lumber

Prices Are Delivered, Per M Ft., B. M., No. 1 Common, Rough

New York—Timbers, to contractors, at site of job in Manhattan, in 20 ft. lengths and under:

	Long-leaf Yellow Pine	Douglas Fir
3x4 to 8x8	$45.00	$27.00
3x10 to 10x10	52.00	28.00
3x12 to 12x12	63.00	28.00
3x14 to 14x14	70.00	33.00

Chicago—Timbers, pine, in 20 ft. lengths and under; fir, up to 32 ft:

	Long-Leaf Yellow Pine	Douglas Fir
3x4 to 8x8	$42.50	$42.50
3x10 to 10x10	49.50	44.50
3x12 to 12x12	62.50	44.52
3x14 to 14x14	72.51	45.50

San Francisco—Douglas fir timbers:

	10-16-18 and 20 Ft.	22 and 24 Ft.
3x3 and 4	$35.00	$37.00
3x6 and 8	35.00	37.00
3x10 and 12	35.00	37.00
3x14	38.00	39.00

Other Cities—Timbers, boards, etc.:

	8x8-In. x 20 Ft. and Under				3x12 to 12x12-In. 20 Ft. and Under	
	Pine	Fir	Hemlock	Spruce	Pine	Fir
Atlanta	$40.00	......	......	......	*$50.00*	......
Baltimore	35.00	$48.00	$52.00	$58.50	72.00	$48.00
Birmingham	*29.00*	......	......	......	33.00	......
Boston	*50.00*	46.00	46.50	48.00	*53.00*	43.00
Cincinnati	42.50	55.00	......	......	52.50	52.50
Cleveland	54.00	54.00	......	......	52.00	52.00
Dallas	55.00	47.50	55.00	55.00	55.00	47.50
Denver	......	40.50	55.00	......	......	49.00
Detroit	53.00	51.00	......	......	63.00	51.00
Kansas City	35.00	35.00	35.00	......	55.00	40.00
Los Angeles	......	41.50	......	......	......	42.50
Minneapolis	40.00*	*40.00*	......	......	40.00*	*40.00*
Montreal	......	41.75	......	40.00	40.00	41.75
New Orleans	38.00	38.00	......	43.00	63.00	58.00
Philadelphia	45.00	42.00	36.00	40.00	55.00	40.00
Pittsburgh	*48.00*	*55.00*	65.00	66.00	**60.00**	*58.00*
St. Louis	42.50	41.50	38.00	......	57.00	42.50
Seattle	......	16.00	......	......	......	15.00

	1x10 In. x 16 Ft. and Under			2x10 In. x 16 Ft. T. & Gr.	
	Pine	Fir	Hemlock	Pine	Fir
Atlanta	*$45.00*	......	......	$32.50	......
Baltimore	52.00	$43.00	$42.00	......	......
Birmingham	*31.00*	......	......	*33.00*	......
Boston	*45.00*	41.00	41.50	47.00	$45.00
Cincinnati	45.00	47.50	......	35.00	45.00
Cleveland	44.00	37.00	37.00	42.00	54.00
Dallas	60.00	......	......	55.00	......
Denver	......	31.00	36.00	......	45.00
Detroit	48.00	45.00	......	43.00	43.00
Kansas City	40.00	40.00	......	35.00	33.00
Los Angeles	41.50	41.50	......	......	48.50
Minneapolis	*35.00**	*35.00*	......	*35.00**	*38.00*
Montreal	45.00	43.25	40.00	......	38.25
New Orleans	39.00	39.00	......	54.00	48.00
Philadelphia	48.00	40.00	35.00	49.00	40.00
Pittsburgh	40 00	47.00	*35.00*	40.00	**53.00**
St. Louis	37.50	42.50	42.50	29.50	33.00
Seattle	......	15.00	......	......	16.00

*West Coast Pine.

PILES—Prices of Nichols Bros., 90 West St., N.Y.C., per linear foot, pine, with bark on, f.o.b., New York; delivered from barge, 1¾ to 2c. per ft. additional:

Dimensions	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.10	$0.165
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.145	.215
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.17	.235
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.205	.345
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.2225	.295
14 in.—2 ft. from butt	5 in.	80 to 85 ft.	.285	.395
14 in.—2 ft. from butt	5 in.	85 to 89 ft.	.325	.435